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USSR REPORT

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GENERAL

CSSR COOPERATION IN GAS INDUSTRY NOTED

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 12, 1982 pp 15-17

[Article by Mikhail Kuchala, CEMA Secretariat: "CSSR Cooperation in the Gas Industry"; passages enclosed in slantlines printed in boldface]

[Text] Summing up the past sixth Five-Year Plan, the XVI Congress of the Communist Party of Czechoslovakia stated, that in the CSSR for the years 1976-1980, national income rose by 20 percent, 90 percent of its growth was achieved due to an increase in labor productivity. The target plan was successfully fulfilled in the areas of industry, construction, agriculture, social maintenance, etc.

One of the deciding factors of these successes was, undoubtedly, the comprehensive political and economic cooperation with other countries, members of the SEV, above all the CSSR. Mutual commodity circulation of the CSSR with socialist countries at the end of the sixth Five-Year Plan comprised 65 percent of its overall foreign trade. "Deliveries of oil, natural gas, a number of basic raw materials, machines and equipment from the Soviet Union, as pointed out in materials of the XVI Congress of the Communist Party of Czechoslovakia (CPC), assured the development of our national economy."

In Fundamental Directions of Economic and Social Development of the CSSR for 1981-1985, adopted by the congress in accordance with lines of construction of a developing socialist society, basic goals in development of the country and means of their achievement in the seventh Five-Year Plan were defined.

Further upsurge in the economy and its more effective growth in the '80s depend on highly active participation by CSSR in international division of labor, especially in the limits of socialist cooperation. In "Fundamental Directions," tasks were set to intensify the most important branches of the economy, among which is gas supply, and where broadening the complex of transit pipelines to create conditions for increasing the import of natural gas was stipulated. Also outlined were growth in the volume and increase in effectiveness of geological exploration for oil and natural gas in Moravia and Slovakia, and improving techniques and equipment for superdeep drilling.

Use of heating gas in our country was begun more than a century ago in 1845, when the first factory began to produce lighting gas in Prague. Growth in

its consumption occurred relatively slowly. This was explained by the insufficient number of factories and high price of gas. Thus, in 1925, consumption of lighting gas comprised about 76 million m^3, and in 1945--nearly 142 million m^3, i.e., in 20 years it only doubled. The gas industry supplied primarily public utilities with the so-called point supply.

A new stage in the development of the Czechoslovak gas industry began after publication of the nationalization decree for lighting gas factories in 1945, which in 1946 applied to the entire area of geological exploration and extraction of natural gas and oil. This permitted to carry out a unified State policy for development of the gas industry, planned production and supply of gas, to carry out central capital expenditures of gas factories and transport equipment.

Qualitative changes occurred in the equipment and technology of oil and natural gas geological survey work. Percussion drilling yielded its position to rotary- and turbodrilling. From the USSR, we received BU-40 light drilling rigs, as well as the newer and more powerful UZTM type and "Uralmash-5D," cementation units, and other modern equipment. The network of main gas pipelines was expanded and plants producing lighting gas were modernized. Deposits of natural gas in the area near the city of Malatski expedited further development of the gas industry. Natural gas began to be used for production of lighting gas or for enriching heating gas with less calorific power, and then for direct supply to consumers. So, in the years 1950-1955, in the regions of Western Slovakia and Southern Moravia, a number of industrial plants were converted to natural gas. Natural gas was also delivered to Prague.

Use of natural gas was economically more advantageous in comparison to other types of heating gases, however, its known reserves were insignificant. Therefore, the question was raised on the use of Soviet natural gas. Toward this end, the "Bratstvo" gas pipeline was placed into operation in the CSSR in 1967. Through it, for the first time, Soviet natural gas began to be transported to various regions of the CSSR, and also to Austria.

In the last Five-Year Plan, the most significant integrated action by member-states of the CEMA, implemented in accordance with the "Agreed Plan of Multilateral Integration of Actions," was the construction of the gas pipeline from Orenburg to the western border of the USSR, in which the CSSR participated. With the combined forces of the CEMA member-states, a gas pipeline 2,750 km long, with a diameter of 1,420 mm, operating at 7.5 MPa, was constructed in an extremely short time and, in 1978, was placed in operation. For participating in the construction of this pipeline, 2.8 billion m^3 of gas are supplied to the CSSR annually.

Development of the gasification in Europe gave rise to the necessity of transporting the gas from the USSR through the CSSR to the GDR and countries of Western Europe. In connection with this, in accordance with an agreement between the Governments of the USSR and CSSR, a complex of transit gas pipelines was constructed. In construction of its first threads, the GDR participated. The complex has been reliably functioning for 10 years already.

Its first phase yielded the possibility to transport 28 billion m^3 of gas per year, the second--almost 37 billion m^3 a year, and currently the third is under construction, and construction of the fourth thread is being planned. After their completion, the power of the entire gas pipeline complex will be nearly 70 billion m^3. The CSSR is becoming the largest transporter of natural gas in Europe.

In accordance with agreements, signed in the FRG in 1981 and in France in 1982, and also with several other countries, beginning in 1984, the USSR will increase the supply of natural gas to them, which will be transported through the CSSR. Recently, an agreement until the year 2008 was signed between the CSSR and USSR on supplemental transit of soviet natural gas. Its fulfillment will exert a favorable trade influence on the natural gas industry, and on the entire national economy of the CSSR.

As is known, the CSSR has taken part in the work of the CEMA Permanent Commission on Cooperation in the Oil and Gas Industry from its inception (1956). This cooperation encompasses a wide sphere of questions on geology, drilling, extraction, transport, storage, and rational use of gas. It is primarily aimed at improved application of economic and natural conditions of member-states of the Council in order to develop the gas industry of these countries more effectively.

Scientific and technical cooperation occupies an important place in the interaction of fraternal countries in the gas industry. The CSSR signed a series of agreements on the following urgent problem, encompassing the whole circle of exploratory work--extraction--use of gas.

/Development of methods and technical means for automatic processing and storage of oil-industry and field geophysical data./ A significant amount of research and development has been accomplished on this problem on a contemporary global scale, many of which are original. Introduction of these works in 1976-1980 had an overall economic effect above 4.5 million converted rubles for all participant countries. Realization of the cooperation program had an effect on successful development of methods and technology of machine processing and interpretation of oil and gas geophysical data, and promoted an increase in effectiveness of geophysical operations.

/Coordination of exploratory and geological survey operations for oil and gas in geological regions in neighboring countries./ Agreements on coordination of these operations assume a mutual amount of experience and information on performed and planned exploratory operations in oil- and gas-bearing regions, including exchange of documentation on deep wells, and also drawing up of joint geological maps of the investigated regions. An example of this might be the cooperation of the CSSR, PNR, and USSR in the Carpatian area.

/Carry out special production-geophysical and perforating-blasting operations in deep and superdeep wells./ To solve this problem in the HNR, a special brigade was created, equipped with the most modern equipment. Czechoslovakia

and other countries--signatories to the agreement--can use the services of this brigade for geological survey work at high-pressure, high-temperature gas deposits.

/Prevention and elimination of accidents in wells and open oil and gas spouts./ The functions of the coordinator and special accident service in this problem are accomplished by a Hungarian organization--Rescue Center of the State Oil and Gas Industry Trust. Agreements have been developed for exchange of well equipment and other items. After signing the agreement, the CSSR has already made use of these services. Results of cooperation in the given problem will be taken into account in further improvements of the organization and technical equipping of national accident services.

/Development of high-efficiency means for using gas as a fuel and design of gas-using equipment./ The scientific research program on this problem provides for multi-lateral scientific-technical cooperation, specifying development of equipment for more effective use of gas as a fuel in various branches of industry, power production, agricultural production, and public-domestic consumption.

Within the limits of the agreement, thermal diffusion burners for open-hearth and glass-making furnaces that reduce gas consumption by 6-8 percent; pneumatic proportionalizers, that permit regulation of optimal gas and air ratios and with a fuel economy of 10 percent; high-speed and radiant burners, and radial tubes, that save 10-15 percent fuel in various processes were developed and introduced.

For participating countries, the economic effect of international division of labor in scientific research and introduction of developments, comprised nearly 18 million converted rubles a year. The Scientific Research Institute for Fuel Use, in Behovica, and other organizations of the CSSR took part in realizing these operations.

In 1982, the CSSR signed still another agreement on scientific-technical cooperation--"Improvement of Technology for Development of Oil and Gas Deposits and Investigation of More Effective Methods and Technical Means for Increasing Oil and Gas Yield of Formations." The goal of the agreement is to provide more complete extraction of oil and gas at optimal technical and economic indices, and to raise actual production of gas.

The CSSR participates in construction and other scientific-research works within the cooperation limits of CEMA member-states, in particular, in the development of new methods and means of constructing gas mains, that provide a more rapid rate and quality of construction of linear pipeline sections, reduction of labor-consumption and cost of operations by means of improving technology, effective organization, and integrated mechanization.

The greater involvement of the CSSR in the economic and scientific-technical cooperation of CEMA member-states permitted our country to achieve significant successes, among which were those in the area of the gas industry.

Recently, imperialistic circles in the United States have begun to discriminate more severely in relation to the CEMA country-members, resorting to the use of "sanctions," curtailing trade and economic ties. The Reagan administration prohibited export from the United States to the USSR of a whole series of machines and equipment for the oil and gas industry, and then expanded this prohibition to the delivery of similar goods from other countries, with the goal of interfering in the construction of the Siberia-Western Europe gas pipeline. This action drew protests in the FRG, France, and in other countries of Western Europe, whose governments declared the intention to carry out these mutually beneficial arrangements. Attempts by Washington to hamper construction of the pipeline by means of "sanctions" failed, but Washington did not give up efforts to exert pressure by other means. These actions were an obvious breach of the Final Act of the Conference on Security and Cooperation in Europe, where it is stated that "energy resources, in particular natural gas and coal..., appear appropriate areas for strengthening long-term economic cooperation."

In this light, interaction of the CEMA member-states and cooperation of European countries in the area of gas production takes on even greater significance.

* * *

"Transgas": Facts and Figures

200 billion m^3 of natural gas flowed through the transit gas pipeline system since the moment it was placed into operation in 1972; if transport of the first 50 billion m^3 of gas required 5 years, then at the present time, users would receive the same amount of gas in under 2 years.

50 billion m^3 of gas a year will be transported by the "Tranzitni Plynovod" ("Transgaz") enterprise after completing construction of a system of main pipelines in 1984; such a quantity of gas can replace 75 million tons of high-quality coal.

7 billion, 793 million m^3 of natural gas were supplied to 1,600,000 consumers in the CSSR in 1980.

1990--this number designates the year when all users in the capital city of the CSSR, Prague, will be converted to natural gas; replacement of lighting gas with non-toxic fuel of higher calorific power has been taking place since Soviet gas began delivery via the "Bratstvo" pipeline; procedure will be completed in all republics toward the end of this century.

1 hour of operation of the gas transit pipeline system, that transports Soviet natural gas through the CSSR to the countries of Central and Western Europe, gives 16,200 m^3 of the most valuable energy and industrial raw material to the Czechoslovak national economy.

26 billion 690 million crowns make up the capital investment directed until 1984 to the complex and totally new, for Czechoslovakia, branch of international transport; pay-back of capital investments, at current price levels, was calculated at 10 years.

1,744 km--is the cable length for the independent regulating system and communications of the transit pipeline, which connects the central control directorate, 80 checkpoints, compressor stations, and automatic high and low-frequency telephone stations.

1,339 shut-off assemblies, located in the compressor stations, provide immediate shut-off during an emergency or during repair activity on technical equipment; 1,018 such devices are established on the pipeline route; depending on their purpose, they are equipped with manual, electric, or pneumatic controls.

15 m/sec--is optimal flow rate of natural gas through the pipeline; transport [of gas] through the pipeline at an average speed is equivalent to that by automobile or rail hauling. However, it is considerably more reliable, trouble-free, and highly economical.

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EVALUATION OF PETROLEUM WELL UTILIZATION

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 2, Feb 83, pp 9-12

[Article by M. M. Umanskiy and M. M. Sattarov (VNIIOENG) [All-Union Scientific Research Institute of Control and Economic Organization of the Petroleum-Gas Industry]: "National Economic Approach to the Evaluation of the Efficiency of Utilization of Petroleum Deposit Resources"]

[Text] It is constantly necessary to solve problems of various complexity and importance involving various time periods in the petroleum industry. Among them, in particular, is the optimization of the industry's development as a complex technical economic problem that spans questions not only of the petroleum industry, but also of the national economy as a whole.

Moreover, there is a great number of comparatively narrow industrial problems that concern finding, exploring, planning and developing petroleum deposits and that are closely related to the solution of the more general problems indicated above. Among them are problems that may be and must be solved by taking into account closing costs for producing petroleum: determination of the concrete values of the maximum allowed expenditures to prepare unit petroleum reserves of the $B+C_1$ categories in various regions of the country; the economic substantiation of high priority facilities for prospecting and exploring deposits; the economic substantiation of the expediency of changing over from the starting to the following stages of geological prospecting work on the deposits; the separation of petroleum reserves into balance and non-balance reserves; determination of the limit for developing a deposit and the operation of a well; the evaluation of petroleum extraction from the stratum (amount of extracted reserves); selection of a version of developing deposits; determination of the sequence of placing deposits into operations etc.

Problems of selecting directions for the development of petroleum production and its optimal disposition in regions and individual deposits in the country are solved at various planning stages. The practical importance of each obtained solution and respective recommendations depend on the length of the optimization period and adopted optimality criterion.

In this case, the results of short-range optimization frequently do not coincide with the solution of the same problem for long-range optimization conditions. Thus, to provide the best conditions for the operation of the industry

this year or even in the current five-year plan period, petroleum production should be intensified in high-productivity deposits by thickening the well network. At the same time, for a long-range period (15 to 20 years and more) it is necessary to explore and actively develop new deposits. The expansion of the optimization time (planning period) up to 15 years and more and, taking into account, on this basis, the conditions of the industry's functioning, not only during the five-year plan period, but also beyond it, makes it possible to determine beforehand the nature and scales of the problems faced by the industry and concentrate the necessary reserves to solve them.

Optimization of the development of the petroleum industry assumes the use, as a criterion, of maximum national economic effect. So far, there is no single method for calculations using this optimality criterion for all cases. A concrete form for its expression in selecting the development of the petroleum production industry and its disposition in regions and individual deposits in the country is a minimum of capital imvestments and operating costs that satisfy a given need for petroleum with the established limitations. Past expenditures, including capital investments in existing construction facilities or those already started are not taken into account.

If the reference time (yield time of the deposits or the period of reliable forecast of conditions and indicators of their operation) for the considered version of the development of industry is completed not later than the last year of planning then, with a dynamic definition of the problem when conditions for functioning and developing the industry are determined for the years of the planning period, the indicated criterion is expressed by the following formula [1]

$$\sum_{t=1}^{T_\Pi} (K_{ti} + Э_{ti}) B_t \rightarrow \min, \qquad (1)$$

where T_Π -- planning period in years; K_{ti}, $Э_{ti}$ --are respectively the pending capital investments & exploitation costs in the t-th year according to the i-th development version; B_t -- discount coefficient in the t-th year.

Petroleum deposits are usually worked for several decades; therefore, the reference time considerably exceeds the planning period (15 to 20 years). At the initial stage of the reference time, there are high capital investments, while at the closing stage -- high operation costs. To eliminate the non-uniform higher (lower) costs of the output produced during the planning period related to this, for each version of the plan there are first determined weighted annual total expenditures S_i per unit of produced petroleum during the entire reference time according to formula [2]

$$S_i = \frac{\sum_{t=1}^{T_{\Pi}} (K_{ti} + Э_{ti}) B_t}{\sum_{t=1}^{T_{\Pi}} Q_{ti} B_t}, \qquad (2)$$

where Q_{ti} -- petroleum production in the t-th year according to the i-th variation of the industry's development.

Then the total costs during the planning period are determined. The optimality criterion assumes the form [2]

$$S_i \sum_{t=1}^{T_{\Pi}} Q_{ti} B_t \to \min. \qquad (3)$$

The optimal industry development variation is used to adopt national economic decisions for the next five-year plan period. Its indicators that characterize the further development stages during the planning period, are considered as a forecast that must be refined on the basis of initial corrected data as times for accepting the next in turn decisions that arrive.

As may be seen from the procedure cited for forming the optimal plan for the industry, it takes into account deposits of various productivities. Here, a concept unavoidably originates on the maximum allowable costs to the national economy for increasing (maintaining) petroleum production (closing costs for the petroleum). Thus, closing costs are the product of the optimal industrial plan. When there is no optimal plan closing costs are found approximately by ranking the deposits included in the industrial plan according to their decreasing efficiency. Moreover, as stressed by A. S. Astakhov [3], obtaining closing costs from the optimal plan must be combined with the ranking method which will eliminate the effect of fairly complicated and unexpected situations on the value of the closing costs.

Closing costs of petroleum are developed for each five-year plan period. In this case, (like the cited method for calculating the optimality criteria), future costs are taken into account not only for the given five-year plan period, but also for the entire reference time of development, during which petroleum deposits pass through four stages, differing in productivity, duration and value of the unit costs. If some deposits entered the stage of

considerable reduction in production or the closing stage when the production cost of one ton of petroleum is high, then other deposits at the same time are in their initial stages when the greater part of all capital investments is made in drilling wells and other facilities. Under such conditions, when a determination is made of the closing costs, taking into account the time factor, (costs and results of the remote future are economically considerably less important than equal in value costs spent now) eliminates a wrong increase (decrease) in the numerical value of the closing costs for the planned five-year plan period, as it appeared to individual investigators [4]. Moreover, there is a possibility, as envisaged in Methodological Instructions [1] of tying in calculations for the five-year period of operation with plans and forecasts for long-range prospects.

Within the framework of closing petroleum costs, determined as 80 rubles per ton for the 11th Five-Year Plan period, fixes their upper level which, when reached, makes further operation of the deposit inexpedient. In determining the upper level, world petroleum prices are taken into account as well as the condition of the equipment and of the technology of petroleum production and the possibilities for the fullest extraction of the reserves. When the basic method for developing petroleum deposits during the current five-year plan period is the flooding of strata and no capital investments are needed for the development of the deposit, the upper level of the closing costs is 150 rubles per ton.

We will consider the practical utilization of the closing costs of petroleum for the solution of individual industrial problems.

1. Selection of version for developing the petroleum deposit. As has been shown, levels of petroleum production for each individual deposit are set on the basis of the optimal distribution for a given production of petroleum in the country. If this condition is neglected and one limits oneself with local optimization of individual deposit development, then the results obtained may be contradictory to the interests of the industry, and the national economy as a whole. High local efficiency of one or another version is insufficient to establish its optimality. A version may be optimal with an efficiency not the highest of the possible ones, but necessary to satisfy the petroleum requirements of the national economy. This means that, in the given case, optimality cannot be divided into local and national economics, it is always only national and to provide for it, individual deposits may be developed with an efficiency less than is locally possible. Therefore, to select the optimal development version for each individual deposit it is necessary to consider all possible versions for all deposits in the industry as a whole. A simultaneous, systematic optimization, common to all deposits, is necessary.

It does not follow from here that without it the selection of a version for developing individual deposits, being put in operation, or a review of a version of operated deposits already adopted when refining their geological physical features is impossible. It would otherwise be necessary to recalculate again and again the optimal plan for the industry as a whole which is not practical even when using a high speed computer.

Moreover, this is not necessary since the closing costs are general for all deposits that comply with the parameter whose use makes it possible to find versions of optimal, from the national economic viewpoint, for developing individual deposits without reviewing the optimal plan of the industry in each case.

Therefore, having determined the closing costs, it is possible to limit oneself by local optimization and be assured that the general goals of the industry are achieved in this case. The best of the possible versions is one which produces the maximum national economic effect R, determined as the difference between closing costs and pending total capital investments and operational costs for developing a concrete deposit:

$$R = \sum_{t=1}^{T} Q_t Z_t B_t - \sum_{t=1}^{T} (K_t + Э_t) B_t. \quad (4)$$

Here T -- period of developing a deposit in accordance with the considered version in years; Q_t -- petroleum production in the t-th year in accordance with the considered version in tons; Z_t -- norm for closing petroleum costs in the t-th year in rubles per ton; K_t $Э_t$ -- capital investments and exploitation costs in the t-th year in accordance with the considered version in rubles.

If closing costs for petroleum production are not used, it would be difficult to determine whether it is expedient to develop a deposit at a cost of 70 rubles per ton, or a development version should be used with half the closing petroleum yield, but with costs only 20 rubles per ton. The solution would thus be adopted from the efficiency of the local and not the national economic position.

An important feature of the version selection using closing petroleum costs is also the possibility of comparing versions, different in costs, as well as in the results (volume and dynamics of production and development time), without preliminarily equating them by introducing an auxiliary facility, as is done when using reduced costs. Closing deposits used in the final stage, have zero evaluation and have no effect on the national economy.

When it is impossible to develop an optimal industrial plan by mathematical simulation, closing petroleum costs, making it possible to select individual deposit development versions by local optimization, provide the possibility of searching for more efficient versions for developing and disposing of petroleum production of the industry as a whole.

Thus, opinions on the impossibility of orientation on closing costs in selecting design solutions when developing petroleum deposits [4] have no basis in fact.

2. Separation of geological reserves of petroleum and the gas dissolved in it into balance and nonbalance reserves and the determination of the extractable part of the balance reserves. The object of planning geological prospecting work for petroleum is the preparation of reserves of petroleum and gas dissolved in it, which it is possible and economically expedient to extract with the fullest utilization of the achievements of modern science and technology. At the same time, balance reserves of the deposit are fixed. Therefore, in solving the problem on separating the deposit reserves, calculated by the volumetric method into balance and nonbalance, it is necessary to determine not only the volume of possible reserve extraction (this is a different problem), but also the economic expediency of developing the given facility at the modern stage of equipment and technology.

Based on such a statement of the problems, the method for their solution is determined. If, at the facility (bed, individual section, differing by collector properties from the basic part, a petroleum fringe) it is possible to drill some number of producing wells (even one) using modern equipment, then for capital investments and operational costs per ton of the produced petroleum not exceeding the upper level of the closing costs, all petroleum reserves and gas dissolved in it in the facility are considered as balance.

If working the petroleum and gas reserves at the facility is technically impossible or because being within the upper level of closing costs not even one producing well can be placed at this facility, such reserves are considered nonbalance. The extractable reserves will be equal to the amount of petroleum produced during the period of working the deposit before reaching the upper level of the closing costs. An economically substantiated final coefficient of petroleum yield is determined as a ratio of petroleum accumulated during this period to its initial balance reserves.

It should be noted that some scientists deny the expediency (even the possibility) of using closing costs when selecting a deposit development version and in the solution of other industrial problems. Obviously this is related to the fact that with increasing scales of petroleum production in the country there was no clear-cut feeling until recently that unrenewable petroleum resources are limited, as well as to the fairly widely distributed false concept on the nature of closing costs, the method of their formation and action. This, in particular, was reflected in warnings to all mining industries not to be carried away by closing costs since they, supposedly, do not conform to the "problem of complete satisfaction of the social requirements in useful minerals under conditions of limited labor, material-equipment resources and volumes of capital investment allotted to industries in the national economic plans" [4]. Actually, closing costs of petroleum and other useful minerals are the products of an optimal plan and are thereby tied closely to the problem of satisfying the needs of the national economy and limitations on capital investments, material, manpower and natural resources specified in the plan. This determines their essence as maximum evaluations of the optimal plan.

Therefore, an increase in the level of the closing petroleum costs established by the optimal plan does not lead to too much thickening of the well network and a drop in their yield, the appearance of well interference, raising the

capital investemnts in the deposit development, and does not violate optimal proportions in the development and disposition of the industry. This only signifies the necessity because of the limited production possibilities of the best deposits, to develop further less valuable deposits to satisfy the national economic needs in petroleum.

Closing petroleum costs are an efficient means of solving concrete problems of optimal planning at various levels of industrial management. Their fastest practical utilization, further development and improvement of application methods will facilitate the efficient achievement of the goals set for the petroleum industry.

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ECONOMIC EFFECTIVENESS OF NEW PETROLEUM TRANSPORT EQUIPMENT

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 2, Feb 83 pp 60-63

[Article by G. Sh. Kudoyarov: "Economic Benefits of New Oil Transport Technology"]

[Text] Petroleum pipeline mains -- are an important component part of a unified transport system of the country that provide a considerable increase in transport work. They are in second place after RRs in the increase in the volume of all kinds of loads (without motor vehicle transport), while they are ahead of all kinds of transportation in the productivity of labor [1]. Every year the national economy of the country saves up to 2.5 billion rubles by using petroleum as compared to RRs to transport petroleum.

This is achieved not only as a result of the effect of the technical-econonic features of pipeline transport (laying pipelines along the shortest distance, relatively low unit resistance to the flow, good seal, independence from climatic conditions, high level of automation, low labor-intensity etc.), but also due to new equipment and technology that improves the economic indicators of the pipelines. The special feature of petroleum pipeline economics is the considerable (up to 80%) unit costs that do not depend on change in the volume of pumping, while this indicator in RR, river and marine transport is 40, 30 and 5% respectively. This means that the best economic indicators for petroleum pipelines can be reached at their maximum loading and the greatest effect from introducing new equipment is obtained when its use is specified as a component part of a newly planned petroleum pipeline.

The basic parameters of a petroleum pipeline are its diameter and the number of pumping stations, determined by the required volume of pumping and not changed after all stages of the pipeline construction are completed. In this connection, the effectiveness of the new equipment on petroleum pipeline transport depends mainly on the results of the renovation of the line part and, to a smaller degree, -- on the pumping machines and reservoir pools [2].

The decisive role is these three components in forming the economic effectiveness of the indicators is determined by their specific weight in the economic indicators of the petroleum pipelines. Thus, capital investments in the line are up to 75% and more of the total cost of building the pipeline: capital investments in the main pumping station and its reservoir pool are about 60% of the total cost of building them and in an intermediate pumping station

-- more than 33% of all costs for building it. Moreover, cost amortizations for pumping petroleum are about 50%, while electric power costs, depending upon the type of pumping machines, reach 35 to 50%.

The basic directions of technical progress in petroluem pipelines are increasing their diameters; improving pumping machines, pumping technology; automating and telemechanizing; introducing automatic control systems and using new materials.

Increasing the petroleum pipeline diameters, improving the pumping technology by raising working pressures are possible only in newly built pipelines, while other measures can be taken on existing pipelines as well as pipelines being built.

The use of new equipment at the pipeline planning and construction stage may be specified for all three of its components (line, pumping machines and reservoir pools). Basic in this are increasing the diameters of the pipelines, the use of unit-set pumping stations, reservoirs with greater unit capacities with pontoons, automation and mechanization, the use of new insulation materials for pipes etc.

An increase in the diameters of the pipelines depends on the required volumes of pumping and is the most efficient method for improving its technical-economic indicators. Thus, a diameter increase from 530 to 1220 mm, reduces unit costs for pumping petroleum by 65%. In 1980, pipelines 720 mm and larger in diameter pumped 78% of the volume and 74% of the load turnover of all petroleum pipelines. Because of greater pumping volume during the 10th Five-Year Plan period, about 50 million rubles of operational costs were saved. At the same time, increasing pipeline diameters cannot be a purpose in itself and without limit, since it is determined only by large and stable petroleum deliveries, and is related to reducing the maneuverability of the petroleum pipeline system due to the concentration of these deliveries, i.e., it is caused by objective factors.

The use of new equipment at the planning stage of the pumping machines is also determined by the required volume of petroleum pumping. The pipeline diameter selected, taking this into account, automatically determines the selection of pumping machine parameters. Increases in the diameters of the pipelines raise the capacities of pumping machines and, at the same time, the unit costs of their operation are reduced. The use of 720 mm diameter pipelines and higher productivity pumping machines saved about 20 million rubles by reducing electric power consumption.

A further increase in the efficiency of pumping machines is related to the creation of a controlled drive for the pumps, as well as the construction of unit-set pumping stations. The latter does not depend on changing the parameters of the pumping machine units, but on using highly prefabricated units that would make possible reduced construction time of the pumping stations and accelerate putting the pipelines in operation. Even if building unit-set pumping stations is tied to capital investments exceeding one-time costs for building the pumping station in the traditional form, it is usually economically expedient because construction time can be reduced to a half or a third.

The scale of using new equipment at the planning stage of the reservoir pool is determined by building larger unit capacity reservoirs. The most widely used are the 20,000 m^3 steel reservoirs. The use of 50,000 m^3 unit capacity reservoirs makes it possible to improve noticeably the technical-economic indicators of petroleum pipeline reservoirs. The annual economic effect of one 50,000 m^3 RVS reservoir, instead of several with capacities of 20,000 m^3, is up to 80,000 rubles. However, there are few such reservoirs so far and their total economic effect is comparatively small.

The decisive role in forming indicators of economic effectiveness of new equipment at the stage of its planning belongs to the line part of the petroleum pipelines although the indicated measures do not exhaust the list of new equipment specified in the construction projects of the pipelines. It includes also measures to automate and telemechanize pipelines; using new design-planning solutions; new materials and increasing the amount of prefabricated structures; introducing progressive technology for building pipelines and organizing their operation according to modern control methods etc.

The list of measures on the new equipment to be introduced in production in the process of pipeline operation is considerably greater than at the stage of their design and construction. Up to 60-80 measures on new equipment are specified annually for Glavtransneft' [Main Administration for Transporting Petroleum] enterprises according to plans for introducing advanced technology, and automation and mechanization facilities for production processes. However, not everyone of them will be used in the entire pipeline network since some of them (for example, devices for monitoring the thermal insulation of the "hot" petroleum pipeline, the introduction of furnaces for preheating petroleum at the Kalamkas-Shevchenko pipeline, improvement of the method for vibration at petroleum preheating furnaces etc.) are applied rarely by their very nature. Most of the plan for new equipment isused practically at all administrations of petroleum pipeline mains, and the expansion of their use would facilitate a more noticeable improvement in the technical-economic indicators of petroleum transport.

The line part of the petroleum mains, unlike the other components, wears out very slowly so that measures for new equipment and technology in its operation are limited. They include the use of scrapers and piston dividers for cleaning the inner cavity of the petroleum pipeline, type "Plastobit-2M" insulation, the introduction of thyristor cathode protection at the stations, ultrasonic leak detectors, systems for smoothing the pressure wave in pipelines, a flaw detector monitoring laboratory, the use of blasting technology for cutting pipelines etc.

During the 10th Five-Year Plan period, 97,000 kilometers of petroleum pipelines were cleaned by means of scrapers (SMR-1220, SMN-1200x1000 etc.). The economic effect due to a reduction in electrical power costs because of a reduced pumping station pressure after the pipeline cavity was cleaned, was 3.5 million rubles. The main factor in the effectiveness in using a new type of bituminous plastic "Plastobit-2M" insulation was the longer life of the insulation cover of the pipeline. The results of experimental investigations and laboratory tests indicated that this type of insulation can last

without replacement not less than 35 years. In 1976-1980 it was used for insulating 245 kilometers of 273 to 720 mm diameter pipelines which saved 2.6 million rubles.

Considerable economic effects were obtained from measures for introducing new equipment for capital repairs of the line part of the pipelines. The introduction in 1976 to 1980 of 141 units of various machines, devices and installations, necessary for the mechanization of practically all kinds of work in capital repairs of various diameter pipelines, saved over 2 million rubles.

The list of measures on new equipment at pumping stations is longer than that for the line part since in it are concentrated basic types of equipment, production facilities and structures of the petroleum mains. Usually, 75% and more of the measures for the plan of introducing advanced technology and mechanization of Glavtransneft' and 90% for the plan of automating production processes are applied at these facilities.

One of these measures -- replacing cast iron pumps by steel pumps -- made it possible to raise working pressure and increase pipeline productivity. The economic effect of introducing about 140 pumps with steel bodies in the 10th Five-Year Plan period was about 4 million rubles. A considerable economic effect (about 1.5 million rubles) during this period was obtained by introducing improved designs of end seals (1900 pairs) for mainline pumps.

Basic measures for introducing new equipment in the process of operation of reservoirs were: equipping them with pontoons made of synthetic materials; using respiratory fixtures of new design; using hydraulic scouring systems for paraffin deposits; installations for cleaning reservoirs. The use of new respiratory fixtures saved over 1 million rubles during the 10th Five-Year Plan period, while the introduction of paraffin deposit cleaning systems saved about 260,000 rubles.

A considerable amount of work on introducing new equipment was the automation and telemechanization of production processes at all three components of the pipelines as well as the introduction of ASU [Automatic Control System]. Among these measures implemented in the 10th Five-Year Plan period were: telemechanization of the line part of the pipelines by introducing 40 TM-200 systems which saved about 2 million rubles; the introduction of 19 "Pusk-71" systems which saved 640,000 rubles; the use of 31 automatic data-measuring systems to record and monitor electrical power which saved 730,000 rubles; automation of 25 reservoir pools which saved 770,000 etc.

ASU introduction was used to assimilate 5 automatic control systems and automatic technological process control systems. To evaluate the economic effectiveness of their introduction, a method was used based on taking into account the effect of the increase in the industrial output when the ASU was introduced. The specific feature of the transport is the expediency of increasing its volume of operation only when there is an increase in the volume of production. However, assimilation of increasing volumes of petroleum pumping is always taken into account when selecting the parameters of a

future pipeline, and is a consequence of reserves planned for it (calculation of pipeline productivity in the cold period of the year, operation 350 days per year etc.), and not the result of ASU introduction since working pressures are determined by the strength indicators of the pipe and not by the use of a given system. In this connection, the ASU effectiveness indicators are somewhat overestimated. However, as a whole, the economic effectiveness of introducing new equipment for petroleum mains in 1976-1980 had fairly high indicators (see Table).

Table

Trends in Introduction of New Equipment

Indicators	Advanced Technology	Mechanization	Automation
Economic effect, million rubles	36.7	2.1	21.6
Capital investments million rubles	90.0	1.1	40.9
Unit economic effect per ruble of capital investments ruble/ruble	0.4	1.9	0.5

Data shown in the Table reflect the economic effectiveness of basic measures on introducing new equipment according to the Glavtransneft' plan and does not include numerous measures specified by plans of petroleum main administrations that also have considerable economic effects. The total economic effect of building new petroleum mains of large diameters using high productivity pumps and implementing measures on introducing new equipment in pipelines in operation in the 10th Five-Year Plan period was about 130 million rubles.

The growth in the pipeline network is determined by the development of the petroleum producing and petroleum reprocessing industries. Since the main problem of the petroleum industry in the 11th Five-Year Plan period is fulfilling the planned tasks on petroleum production as a result of its increased production in Western Siberia and northern regions of the European part of the country, the problems of developing mains for petroleum transport in the very near future are in assimilating the technology of pipeline transport of petroleum from these regions as well as its transport from Western Siberia to new points of its reprocessing (Baku, Chimkent, Chardzhou).

Technical progress in petroleum mains will affect all their components. For new mains it will consist of using larger diameter pipes made of thermally strengthened steels; improving industrial methods for building pumping stations by using unit, unit-modular and open-air stations; building higher unit

capacity reservoirs; carrying out a complex of measures to improve the technological equipment; raising the level of the automation of production processes; using modern methods to control technological processes etc. At existing pipelines it is planned to introduce new equipment and technology in the process of their expansion, modernization and reequipment. Basically, the measures will involve the same kinds of new equipment as those introduced in the 10th Five-Year Plan period and some new measures will be added (expansion of the use of the "Plastobit-2M" insulation covers; improvement of the electrochemical protection for pipelines; modernization of the shut-off fixtures and pump equipment; the use of gas-equalization equipment, pontoons and respiratory fixtures of improved design on the reservoirs; introduction of automatic and telemechanic means to control technological pumping processes etc.).

The economic effect of their introduction at existing pipelines will be about 67 million rubles in 1981-1985, according to a preliminary estimate, i.e., the level of the 10th Five-Year Plan period will be exceeded. This will facilitate an improvement in the technical-economic indicators of petroleum transport.

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2291
CSO: 1822/163

TECHNICAL DIAGNOSIS PROPOSED FOR INCREASED POWER PRODUCTION EFFICIENCY

Kiev ENERGETIKA I ELEKTRIFIKATSIYA in Russian No 1, Jan-Mar 83 pp 1-5

[Article by V. F. Sklyarov, minister of power and electrification of the Ukrainian SSR]

[Text] In fulfilling the decisions of the 26th CPSU Congress to increase the republic's energy potential, the output of the Ukrainian power stations was brought to 45.2 million kW by the end of 1982. New power stations were started up: Kiev TETs-6, Zuyevka GRES-2, and the South Ukraine AES. Electricity production at the power plants of the Ukrainian SSR ministry of power and electrification increased 1.6-fold as compared to 1970. However, the outlays for overhaul alone during this time rose 2.2-fold. One of the significant reasons for this trend is the lack of an industry system for technical diagnosis. Evaluation of the current state of equipment for this reason is done without the use of new technical resources, the volumes of repair operations are defined by the old method, intuitively, and the operating reliability of the main equipment rises at slow rates.

The time has come to review the existing practice, mainly in the repair industry. Optimal volumes of repair operations should be done with maximum efficiency, using the necessary scientific-technical developments for this purpose.

An important factor in guaranteeing power production efficiency should be the creation of an industry system of forecasting technical diagnosis which is based on a comprehensive approach.

This requires solution to a number of interrelated questions: determination of the equipment and its parts for primary diagnosis, selection of the indicators, methods and resources for this, distribution of functions between the local and central diagnosis resources, development of scientifically substantiated methods for planning repair based on the forecasting diagnosis, and optimization of the maintenance of the sector.

Even these tasks are sufficiently complex because of the diversity of the power equipment, the lack of reliable methods of diagnosis and forecasting, sufficiently accessible computers and service equipment, necessary sensors for measuring the actual condition of the equipment, etc.

This article attempts to present the main technical principles for setting up industry automated system of forecasting diagnosis (IASFD) which has the functions of determining the actual condition of the equipment and timely detection of units with defects.

The organizational principles of the IASFD are based on the use of a systems approach to solving the developing problems, in particular, application of principles of decomposition, unitizing, unification and equivalence.

The technique of selecting IASFD can contain the following stages:

--Classification of industry equipment (electrical, electromechanical, heat engineering, electronic), which in turn is represented by a set of blocks;

--Determination of the parameters which should and could be predicted from the measurable which characterize the actual condition, whose deviation is recorded by the extant measurement devices;

--Compilation of diagnostic models for individual designs of power equipment and determination of additional criteria of diagnosis;

--Isolation of parameters which are important for the system as a whole and determination of the possibility of measuring them;

--Conducting of procedures of information compression for different hierarchical levels (foreman, shop head, chief engineer, etc);

--Selection or construction of a forecasting model for sections, power units and the system as a whole;

--Distribution of a limited number of computers according to the diagnostic tasks;

--Selection of the composition of the computers and their program support;

--Correction of the plans and volumes of repair using information of the forecasting diagnosis with the help of computers.

We will examine realization of these stages in more detail. Each of them can be solved by combining both formal and heuristic procedures with the involvement of different methods of mathematical modeling.

Use of IASFD is effective because of more accurate and rapid analysis of the optimal volume of repair and decrease as a result in the volume and cost of subsequent repairs, improvement in equipment reliability, decrease in the percentage of units verified without substantiation, the use of diagnostic resourses to evaluate the current condition of the equipment.

The IASFD is a complicated system, therefore it is expedient to set it up on a hierarchical plan with local subsystems of the lower level for power equipment and a central diagnosis system for the entire power system and the industry which has a central data bank for equipment damage. The second main principle of IASFD organization is maximum unification for all levels in order to reduce the requirements for the computer equipment.

We will examine an illustration of the general technique. Forced shutdowns of the blocks in the industry are distributed as follows.

In 1980-1982 roughly 63 percent of all the forced shutdowns occurred because of the steam generators versus roughly 3 percent because of the generators and 10 percent because of turbine vulnerability to damage.

In turn, an average of 93 percent of all the forced shutdowns of the blocks because of the boilers occurred because of damage to the heating surfaces. A total of 53-54 percent of them were caused by damages to the steam-superheaters and roughly 30 percent because of damage to the screens. The water economizers were responsible for about 15.5 percent.

Every second damage to the steam superheaters was associated directly or indirectly with temperature overshooting (exceeding of the permissible temperature level of the medium and the metal).

The conclusion follows from here that the least reliable equipment in the industry is the hot water heaters, and among them, the heating surfaces, and further, in turn, steam superheaters. It is expedient to select either the temperature, or the time resistance of the metal for the heating surfaces as the integral diagnosis and forecasting criterion.

Organization of a local diagnostic system as applied to the selected specific object assumes fulfillment of the following stages:

--Compilation of a mathematical description of the object;

--Obtaining of a diagnostic model on its basis;

--Analysis of the diagnostic model and selection of the set of controllable indicators;

--Appraisal of the reliability of the selected indicators;

--Selection of resources (method, apparatus, organizational) for preparing the diagnostic process;

--Development of resources for conducting the diagnostic process, including selection of the monitoring points, resources of communication and processing.

Each of these stages can consist of a number of operations whose implementation uses different mathematical methods and technical resources.

We will illustrate the use of this general technique for diagnosing heating surfaces of hot water heaters.

We will note first of all that the diagnostic model differs from the standard mathematical which is employed, for example, in solving regulation tasks. Thus, for purposes of regulation, an equation of thermal balances is used for the inner and outer pipe walls, flue gases and the working medium which links fuel consumption, temperature of the gases in the medium, heat capacitance of the metal, area of heating surface, etc. This equation is differential, and can be solved by a standard method. It does not carry information about the actual condition of the heating surface, or its future behavior.

The model which characterizes the condition of the steam superheater as a diagnostic object is the relationship which links the time resistance σ_B^t with temperature T, pressure P, pipe design S, and metal grade γ, i. e.,

$$\sigma_B^t = f(T, P, S, \gamma). \tag{1}$$

Failure of the steam superheater occurs when the main stress reaches a certain maximum value σ^{add}, i.e., when the following condition is fulfilled

$$U_\sigma = \sigma_B^{max} - \sigma_B^{add} \geq 0. \tag{2}$$

Relation of type (1) can either be established experimentally or by calculation.

Experimental production of relationship (1) assumes that the method of planning the experiment is used and consists of employing equations of the following type:

$$\begin{aligned} y &= a_0 + a_1x_1 + a_2x_2 + \ldots + a_nx_n \\ y &= a_0 + a_1x_1 + \ldots + a_{1,2}x_1x_2 + a_nx_nx_{n-1}, \end{aligned} \tag{3}$$

where y--dependent variable (for our case σ_B^t); x_i--independent variables, $i=\overline{1,n}$.

One can use calculation to determine σ^t_B when there are known current parameters of the technological process, for which radial σ_r^t and tangential σ_θ^t stresses are computed in the pipe wall using the stress function which satifies the heterogeneous biharmonic equation. The task in this statement is fairly complicated for pratical realization.

Difficulties of establishing relationship (1) experimentally, and considerable computational outlays needed to obtain σ^t_B by calculation mean that full-scale methods of obtaining σ^t_B are primarily used. They require shutdowns of equipment, cutting out of samples and conducting of the corresponding failure tests. This is expensive and slow.

It is expedient to use indirect rapid analyses of σ^t_B by using simpler relationships.

It is common knowledge that the time dependence of metal strength on the duration of its stay in the stressed state τ with assigned temperature T looks like:

$$\tau' = \tau_H \exp\left\{\frac{b_0 - C\sigma^*}{K_0 T}\right\}, \qquad (4)$$

where τ_H, b_0, C_0--quantities which determine the strength of properties of the material; K_0--Boltzmann constant.

The failure condition (1) using (4) can be presented in the form:

$$\eta = \frac{\tau_p}{\tau'} \geqslant 1, \qquad (5)$$

where τ_p--operating time of the steam superheater.

With regard for temperature and pressure fluctuations on individual i-th sections $i=\overline{1, n}$ (5) can be written in the form

$$\sum_{i=1}^{n} \frac{\tau_{pi}}{\tau'_i} \geqslant 1, \qquad (6)$$

where τ_{pi}--loading time in the i-th cycle, while τ'_i is computed using expression (4).

It is easier to solve the problem if we consider σ^* to be constant (one can do so in the first approximation), and to consider only the temperature overshootings. Then expressions (4-6) are also simplified and require recording of only the temperature mode. There are fairly effective means of recording the temperature.

Thus, as is apparent from what has been said, an approximate diagnostic model is selected and temperature can serve as the definitive parameter in it. It is natural that its consideration does not yield complete 100 percent reliability in determining the moment of metal failure, but can serve as one of the estimates, the more so since operating data indicate the dominant influence of the temperature factor on the reliability of steam superheaters.

The main advantage of this approach is that temperature recording has already been well worked out at the extant power plants.

In order to improve reliability, one should use additional resources, for example, the method of acoustic emission, use of heat finders, etc.

The use of a similar approach has been described in [1], where it was applied to creating a system of temperature monitoring. It is realized at the extant hot water heaters as follows:

--Information is recorded and accumulated regarding the temperature modes of different sections of the steam superheaters;

--The service life τ^0_i which remains until the next period of monitoring with regard for replacement of individual sections of the steam superheater during the previous repairs is computed for these temperatures and the assigned design of the hot water heater;

--The total service life of the heater until overhaul is computed.

If the calculations show that the calculated service lives are lower, and the losses are higher than the permissible, then the hot water heater should be sent for overhaul.

Thus, the local system of diagnosis is organized on the basis of the ext nt apparatus and technical resources in the automated system of technological production control and for its realization requires a simple technical support.

The temperature forecasting diagnosis is realized in the following stages:

--Determination of optimal volumes of temperature monitoring and monitoring points which use analysis of the technological process, grouping of parameters and selection of the representative monitoring points;

--Determination of the site of installing the sensors and possibility of improving reliability of the removed information;

--Selection of the period of sensor samplings;

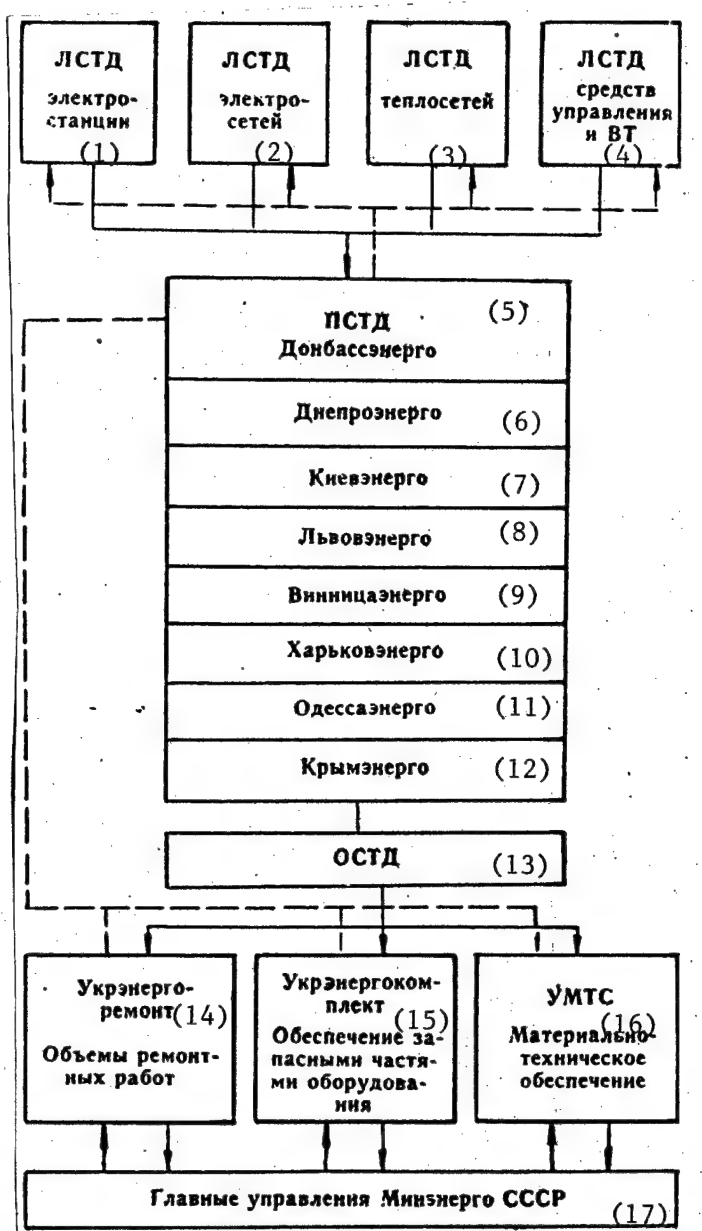
--Compilation of technical requirements for selecting apparatus in program resources to record temperature overshooting and to make calculations according to the selected technique;

--Compilation of method instructions for the plant personnel to use the obtained information to improve the operating process.

This approach is fundamentally applicable for practically any object of power industry if in each specific case a selection is made of one or several methods for determining the actual condition of the equipment.

The methods of monitoring equipment which can be used in the local MC [message center] have already been fairly well worked out. One can note the following among them: thermal (using temperature), vibration-acoustic, acoustic emission, optical, logical, ultrasonic, metallographic, heat-finding, etc.

Figure 1.



Key:

1. Local system of technical diagnosis of power plant
2. Local system of technical diagnosis of power networks
3. Local system of technical disgnosis of heat networks [continued on next page]
4. Local system of technical diagnosis of control and computer equipment
5. Enterprise system of technical diagnosis of the Donbassenergo
6. Dneproenergo
7. Kievenergo
8. L'vovenergo
9. Vinnitsaenergo
10. Khar'kovenergo
11. Odessaenergo
12. Krymenergo
13. Industry system of technical diagnosis
14. Ukrenergoremont, volumes of repair operations
15. Ukrenergokomplekt, supply of spare parts for equipment
16. Adminstration of material-technical supply, material-technical supply
17. Main administrations of the USSR Ministry of Power and Electrification

The reliability of these methods is low in a number of cases. It is therefore expedient to use them in combination, as well as more advanced methods of processing the obtained information.

The industry system of forecasting diagnosis in the general form can be constructed according to a hierarchical principle, and looks as follows (figure 1). The subsystems of technical diagnosis of the PED [planning-economics department] can be presented as a set of local systems, and they in turn should apparently be constructed with regard for technology, for example, for power plants (figure 2).

The interaction of subsvstems can be set up as follows. After using local STD [technical diagnosis system] to define the objects and designs which are most vulnerable to damage, a forecast is made for the periods of their replacement which is transformed into a system of preliminary claims and planned volumes of repair operations.

The subsystems of PED using computers analyze the incoming materials and issue information to the Computer Center of the Ukrainian SSR Ministry of Power and Electrification, where the industry system of TD [technical diagnosis]works out preliminary variants of plans and claims through the corresponding structural subdivisions. Then using feedback with the local STD and TD subsystems, corrections are made, and the claims and plans are sent in the final form to the USSR Ministry of Power and Electrification, from which orders are received for spare parts, materials, etc. with optimal distribution.

The entire process should be automated based on computers.

Since the processes of power structure failure have a stochastic nature, then to solve the tasks of optimal planning of the volumes and periods of repair, composition of spare parts and material-technical support, the theory of mass maintenance, stochastic programmingand a number of other modern methods for solving tasks of regional organization of control and maintenance of complicated systems can be used.

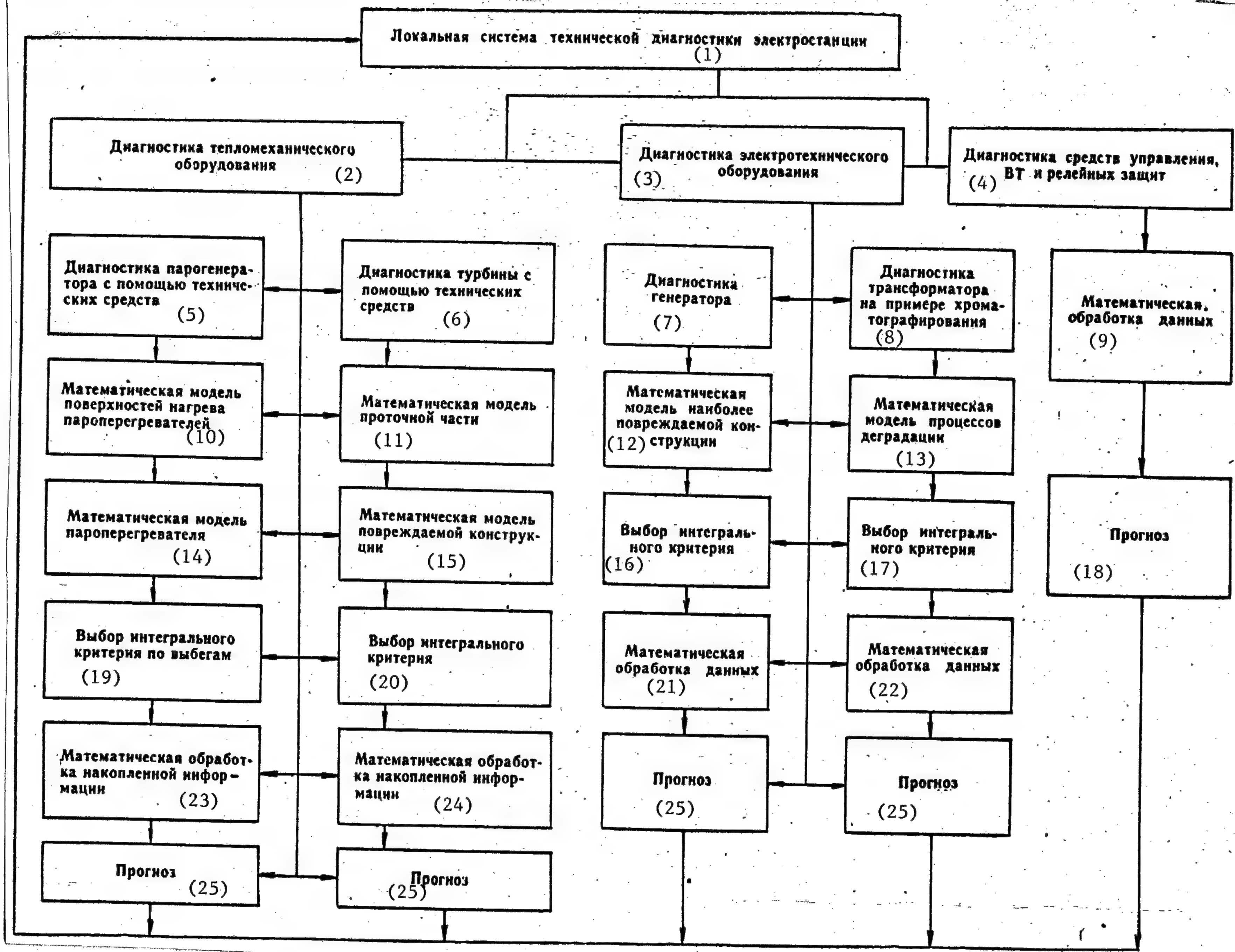
Conclusions

1. The current practice of operational-repair maintenance of equipment needs serious improvement using technical resources of forecasting diagnosis.

2. Optimization of the volumes of repair operations, and considerable improvement in reliability in the main equipment requires the use of modern mathematical methods of modeling the processes, their processing and new instrument support (heat finders, acoustic emission, coercive force meters, etc.).

3. The ext nt reserve for mathematical modeling, resources of technical diagnosis, and the accumulated experience of diagnosing individual designs makes it possible to view the question of creating a system of technical diagnosis as urgentand necessary.

Figure 2.


Локальная система технической диагностики электростанции (1)
Диагностика тепломеханического оборудования (2)
Диагностика электротехнического оборудования (3)
Диагностика средств управления, ВТ и релейных защит (4)
Диагностика парогенератора с помощью технических средств (5)
Диагностика турбины с помощью технических средств (6)
Диагностика генератора (7)
Диагностика трансформатора на примере хроматографирования (8)
Математическая обработка данных (9)
Математическая модель поверхностей нагрева пароперегревателей (10)
Математическая модель проточной части (11)
Математическая модель наиболее повреждаемой конструкции (12)
Математическая модель процессов деградации (13)
Математическая модель пароперегревателя (14)
Математическая модель повреждаемой конструкции (15)
Выбор интегрального критерия (16)
Выбор интегрального критерия (17)
Прогноз (18)
Выбор интегрального критерия по выбегам (19)
Выбор интегрального критерия (20)
Математическая обработка данных (21)
Математическая обработка данных (22)
Математическая обработка накопленной информации (23)
Математическая обработка накопленной информации (24)
Прогноз (25)
Прогноз (25)
Прогноз (25)
Прогноз (25)

Key for figure 2:

1. Local system of technical diagnosis of power plants
2. Diagnosis of thermal mechanical equipment
3. Diagnosis of electrical engineering equipment
4. Diagnosis of control equipment, computers and relay protection
5. Diagnosis of steam generator using technical resources
6. Diagnosis of turbine using technical resources
7. Diagnosis of generator
8. Diagnosis of transformer in the example of chromatographing
9. Mathematical processing of data
10. Mathematical model of heating service of steam superheaters
11. Mathematical model of the circulating section
12. Mathematical model of the design most vulnerable to damage
13. Mathematical model of the degradation processes
14. Mathematical model of the steam superheater
15. Mathematical model of the design vulnerable to damage
16. Selection of the integral criterion
17. Selection of the integral criterion
18. Forecast
19. Selection of the integral criterion for overshooting
20. Selection of the integral criterion
21. Mathematical processing of data
22. Mathematical processing of data
23. Mathematical processing of accumulated information
24. Mathematical processing of accumulated infromation
25. Forecast

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9032
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PIPELINE CONSTRUCTION PROGRESS REPORTED

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 1, Jan 83 p 4

[Text]

Status of Urengoy-Pomary-Uzhgorod Gas Pipeline Construction as of 1 January 1983

Total length of route	4,451 km
Pipe procured	3,900 km
Pipe delivered	2,500 km
Welding:	
Revolving	3,200 km
Overhead	2,200 km
Trenches dug	2,000 km
Insulation	1,800 km

Status of Construction of Export Gas Pipeline (Insulation and Laying), by Main Administration, as of 1 January 1983

Main Administration or Association	Section length, km	Completed, km
Glavsibtruboprovodstroy	728	77
Glavvostoktrubopovodstroy	1,343	586
Glavtruboprovodstroy	1,285	761
Glavyuzhtrubopovodstroy	339	135
Glavukrneftegazstroy	395	138
"Soyuzintergazstroy"	359	103

Status of Construction of Export Gas Pipeline (Insulation and Laying), by Oblast and Autonomous Republic, as of 1 January 1983

Oblast or ASSR	Section length, km	Completed, km
Tyumen	1,043	187
Sverdlov	345	55
Perm	434	186
Udmurt ASSR	206	58
Tatar ASSR	214	90
Chuvash ASSR	129	119
Gorkiy	216	216
Mordvinian ASSR	82	55
Ryazan	71	55
Tambov	137	127
Lipetsk	143	143
Orel	112	48
Kursk	228	120
Sumi	119	33
Poltava	170	20
Cherkassy	48	8
Kiev	115	90
Vinnitsa	210	43
Khmelnitskiy	70	23
Ternopol	58	-
Ivano-Frankovsk	166	90
Lvov	41	10
Transcarpathian	94	34

11004
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UDC 621.643.001.12

BASIC PLANNING DECISIONS OF URENGOY-UZHGOROD GAS PIPELINE DESCRIBED

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 1, Jan 83 pp 5-7

[Article by N. M. Mitsenmakher, YUzhNIIgiprogaz, Donetsk: "Basic Design Decisions for the Urengoy-Uzhgorod Gas Main"]

[Excerpt] The Urengoy-Pomary-Uzhgorod export gas pipeline is being erected simultaneously with gas mains that are to satisfy the energy and production needs of the country's national economy in the 11th and 12th five-year plans. This has significantly predetermined the engineering concepts applied to the export gas pipeline--one of the facilities of the countrywide unified gas supply system. The raw material base of the gas pipeline consists of the central part and northern wing of the Urengoy gas condensate deposit. To reduce the length of gas field collecting mains and the dispersal of gas flows, the central zone of the field was adopted as the starting point of the gas main.

The end point of the gas pipeline in Soviet territory is in the vicinity of the city Uzhgorod, where the "Soyuz" gas pipeline, which transports gas to a number of socialist countries in CEMA, crosses the USSR state border.

The Gas Pipeline Route and Compressor Station Sites

Determination of the general orientation of the Urengoy-Pomary-Uzhgorod gas pipeline was preceded by a program aimed at studying the topogeodesic, geological engineering and geocryological conditions of the route, and at analyzing the technical-economic indicators of the variants under consideration. Besides large-scale topographic plotting boards and maps, aerial photographs were used in the work; the main variants were analyzed in the field by specially formed commissions consisting of representatives from the Ministry of Gas Industry, the Ministry of Construction of Petroleum and Gas Industry Enterprises, scientific research and planning institutes and operating organizations; representatives of specialized organizations belonging to the Ministry of Geology, the RSFSR Ministry of the River Fleet and local economic organs were brought in to examine a number of the complex sections such as crossings over large water obstacles, marshy areas and permafrost zones.

The difficulty in selecting the general orientation of the Urengoy-Pomary-Uzhgorod gas pipeline route lay in the fact that the route of the gas pipeline,

the first in a new industrial corridor, had to be sought with a consideration for the significant difficulties associated with future expansion in a number of the sections, and especially in the initial section as far as the Ob' River.

The conditions in which the last Urengoy-Petrovsk-Novopskov gas pipeline under construction on this route are significantly worse than for the first strands. In the opinion of the experts the crossing that was erected over the Ob' cannot support any further construction. As with this crossing, a new one must insure a possibility for locating a sufficient number of siphons for a multistrand gas pipeline system. Such a section line has been explored and selected several dozen kilometers upriver from the existing crossing. A number of "key" points have been established along the route--crossings over the largest rivers (Nadym, Ob', Kama, Volga, Dniepr) and the Ural and Carpathian mountain ranges. These key points determined the general orientation of the gas pipeline. In the intervals between the key points the orientation of the route was refined by computer using the "Oriyent" program package developed by the YUzhNIIgiprogaz [not further identified] and the MINKh i GP [Moscow Institute of Petrochemical and Gas Industry imeni Academician I. M. Gubkin].

Field explorations conducted later on confirmed the high precision and dependability of the preliminary work on the route's orientation. Thus the figures for the total absolute length of the route determined from field measurements differed from the length initially determined from cartographic materials by 0.3 percent.

There are complex sections of significant length along the entire distance of the route (4,451 km): permafrost--more than 118 km, marshes--200.8 km, flooded territories--758.4 km, rock--795 km.

The route crosses more than 20 large rivers and more 840 medium and small rivers and streams.

Optimization of the basic technological parameters of gas transport was the most important phase of the planning. The diameter of the gas pipeline and the maximum working pressure are determined by the characteristics of the piping, fittings and production equipment presently under production. The productive capacity of the gas pipeline, the power of the gas pumping units, the locations of the compressor stations along the route, the degree of gas compression and the temperature conditions of its transportation were found by computer optimization of the calculations using the "RAKS" program package developed by the Gas Institute of the Ukrainian SSR Academy of Sciences jointly with the YUzhNIIgiprogaz.

The calculations impose unique requirements because the parameters of six strands of gas pipeline possessing different technological characteristics and serviced by variously equipped gas pumping units had to be optimized simultaneously. But this approach was precisely what made it possible to arrive at the most accurate results and economical decisions, which is especially important in connection with the sizeable capital investments into

construction of the gas pipelines, where each percentage point of economy means tens of millions of rubles.

As a result of the calculations the spacing of the compressor stations was made variable, increasing along the route from 100 to 125-130 km owing to consumption of a significant proportion of the transported gas for internal needs, and namely to drive the gas turbine units, the total power of which is 2.0 million kw (this is considering only the working units).

The particular sites were selected on the basis of the topographical and engineering-geological conditions, while the choice of sites in the initial section was also governed by the geocryological conditions, by the engineering support problems encountered, by the proximity of transportation facilities to the sites and by the housing needs of the operational personnel.

The Flow Chart of the Gas Pipeline

The linear part is planned as a single strand of pipes 1,420 mm in diameter. A main and a back-up strand 1,220 mm in diameter are foreseen at complex crossings over water obstacles. Main strands crossing rivers of moderate width are made from piping with a diameter of 1,420 mm.

The back-up strands located at crossings over water obstacles are joined together by connectors making it possible to use them jointly with other gas pipelines of the system.

Loops that equalize the carrying capacity of the gas pipeline along its entire length are foreseen in local sections where the spacing of the compressor stations is somewhat greater than standard.

Connectors with a diameter of 1,020 mm are installed in the vicinities of compressor stations located at crossings over large water obstacles and beside line valves to permit connection to other gas pipelines of the system with the purpose of providing for mutual back-up.

Five gas pumping units with a power of up to 10 Mw generating a pressure of 7.5 MPa in the main are to be installed at the main compressor station in the vicinity of the Urengoy deposit.

The temperature conditions of gas transportation are variable, and they change along the entire length of the gas pipeline depending on season and with a consideration for heat transfer to the ground and the Joule-Thomson effect in each section between neighboring compressor stations. Unusual temperature conditions have been established in the initial section of the route, which passes primarily over permafrost, to include ground that loses its carrying capacity when thawed. Year-round gas transportation at a negative temperature is foreseen for this section. Negative temperatures are achieved in winter by means of AVO [air cooling equipment] and in summer by connecting a special propane-cycle gas cooling station, located at the same site with the Urengoy compressor station.

The gas pipeline is also outfitted with measuring units at the boundaries of the pipeline service territories of different gas transport production associations and at the USSR state border, fixtures permitting the use of pipe cleaning devices, a branch pipe for the population center of Beregovo on the boundary between the USSR and Hungary, gas pipelines connecting to storage tanks insuring stability of gas delivery, and connectors to other operating gas transport systems of the unified gas supply system.

Gas Pipeline Structure

The linear part of the gas pipeline is made of steel straight-seamed arc welded pipes with the following basic metal mechanical characteristics: maximum strength $\sigma_{BP} \geqslant 600$ MPa, yield point $\sigma_t \geqslant 470$ MPa, impact toughness using Charpy samples $a_n \geqslant 0.8$ Mj/m^2 at 253°K.

The adopted pipe dimensions are 1,420×18.7 mm for category I and II sections, and 1,420×15.7 mm for category III sections. Reinforced sections in the vicinity of line valves and compressor station connecting units are made out of 1,420×23.2 mm pipe. The structural units are manufactured at the plant. The gas pipeline is being insulated with sticky polymer tape; the number of layers of insulation and of the protective wrapping was established depending on the pipe laying conditions.

Some of the pipe is being delivered with polyethylene insulation applied at the plant. When such piping is used on the route, only the joints are insulated with tape or with heat-shrinking rings.

Considering the high buoyancy of 1,420 mm pipes and the sizeable longitudinal forces experienced by an operating gas pipeline, dependable ballasting with reinforced concrete weights and with screw and pile anchors has special significance.

The experience of building gas pipelines in West Siberia has now made it possible to strictly differentiate the conditions under which different types of ballasting are used and to determine the requirements on the work procedures, the technical conditions that must be observed when laying the gas pipeline and filling the trench and the sequence of the operations.

The siphon crossings over water obstacles foreseen by the plan make it possible to reduce the number of strands and the pipe cleaning device introduction and removal points, and to make sensible use of the pipeline cleaning system.

Compressor Stations

The compressor stations were planned on the basis of unified concepts approved by the USSR Gosstroy. The entire compressor station complex, including the master plan and the technological, construction and other portions of the plan, has been unified.

The master plan foresees precise differentiation of the production zone from the zone of the production service complex. The production service complex zone, which contains service operational and repair blocks, transportation and storage facilities, a boiler plant and external power supply facilities, is intended to provide services to a system of gas pipelines consisting of six strands, with minimum expansion of individual facilities.

The production zone includes three 25 Mw gas pumping units, each of which is located in a self-contained shelter, gas cleaning and cooling units located on open-air platforms, block operator control rooms, a back-up gas turbine power plant, a unit for preparing and reducing the pressure of transported and fuel gas, and internal utility gas lines.

The built-up area of the compressor station territory is 42 percent, which is in keeping with the best indicators of master plans for industrial enterprises, and which insures a decrease in the length of utility lines and the volume of construction and installation jobs.

Production and Auxiliary Facilities

The following basic facilities have been foreseen in the plan to permit organization and location of operating services and to insure dependable operation of the gas transport system for a long period of time: Structures providing electrochemical protection to underground pipelines against soil corrosion; a multichannel radio relay communication line along the entire length of the gas pipeline, together with remote control channels; a four-channel radio relay communication line intended for the first period of operation; an automated system for controlling the production process of gas transport, to include the appropriate computer technology; a line remote control system and a central control station; central and branch repair bases for production equipment and transportation resources; motor roads and thoroughfares parallel to the route, and approach roads leading to the compressor stations; bases for equipment reception and storage, railroad spurs and moorings to be used by contracting construction organizations and client organizations; hothouses and subsidiary farms, including those using recycled heat from compressor stations.

Moreover a complex of residential, cultural and personal service facilities is foreseen at the locations of compressor stations and other operational services. In the northern region, where there are no population centers near compressor stations, self-contained settlements with a capacity of 400 residents are being erected. In inhabited regions, housing is being built for gas pipeline workers beside the nearest population centers as a rule.

Experimental Section Rated for a Pressure of 10 MPa

An experimental section--a loop 281 km long--is foreseen as a means for developing the procedures of building, and transporting gas through, 10 MPa gas mains, erection of which is to begin at the end of the 11 Five-Year Plan as part of the Urengoy-Pomary-Uzhgorod gas main.

The experimental section includes two compressor stations: the Pravokhet-tinskaya equipped with GPA-Ts-16 units, and the Priozernaya equipped with GTN-25 units.

The experimental section is being erected basically out of multilayered arc welded pipes having a diameter of 1,380 mm and a wall thickness of 21.6 mm (for category III sections) or 26.0 mm (for category I and II sections).

Certain structural units and irregularly shaped parts of the gas pipeline are being made from monolithic pipes with a diameter of 1,420 mm. Installation of excess pressure preventer units equipped with multipositional regulator valves having a nominal diameter of 1,000 mm is foreseen at the places where the experimental section will be connected to the Urengoy-Pomary-Uzhgorod gas pipeline.

Planning Organization

Five planning institutes of the Ministry of Gas Industry have been recruited to perform the complex of planning and surveying jobs associated with the gas pipeline route, which is about 4,500 km long: YuzhNIIgiprogaz (the master planner), Soyuzgasproyekt, Giprospetsgaz, Giprogaztsentr, VNIPItransgaz [not further identified].

Certain portions of the plan were developed by specialized institutes of the Ministry of Gas Industry and of other ministries and departments, to include the Ministry of Communications, the Ministry of Transport Construction, the Ministry of the River Fleet, the Ministry of Forestry, the USSR Gosstroy and others.

The master planner proposed the general idea for the plan, completed the calculations associated with optimizing the gas transport flow chart, did the hydraulic and thermal calculations and compiled summaries on the choice of the general orientation of the route and on the sections of the plan.

All planning decisions are aimed at creating a gas transport system characterized by high dependability and economy and satisfying the present level of gas transport technology.

To unify the engineering concepts applied by different institutes, the master planner drew up the "Basic Planning Premises" and the "Basic Engineering Concepts," which contain the necessary information for anticipatory development of the working drawings and the basic premises of the plan.

The leading scientific research institutes of the Ministry of Gas Industry and the Ministry of Construction of Petroleum and Gas Industry Enterprises--the All-Union Scientific Research Institute of Natural Gas and the All-Union Scientific Research Institute for the Construction of Main Pipelines--took part in the plan's development.

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PLANNING INSTITUTE CONTRIBUTES TO URENGOY-UZHGOROD GAS PIPELINE CONSTRUCTION

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[Article by N. M. Pavlov, NIPIorgneftegazstroy: "NIPIorgneftegazstroy--in Behalf of Construction of the Export Main"]

[Excerpt] Specialists of the NIPIorgneftegazstroy [not further identified] institute participated in a specially created interdepartmental commission during the planning stage associated with determining the technical-economic grounds for the choice of the route's orientation and with the preplanning surveys. Cartographic and laboratory materials provided by the planning institutes and field inspections of individual sections and regions made it possible to thoroughly study three general orientations for the route of the export main: a northern variant (Urengoy-Gryazovets-Torzhok-Ivatsevichi-Dolina-Uzhgorod); a central variant (Urengoy-Gryazovets-Smolensk-Dolina-Uzhgorod); a southern variant (Urengoy-Gornozavodsk-Pomary-Uzhgorod). Variants of each of these general orientations were examined additionally. They included variants of crossing the Ob' River, variants of the southern orientation in the Lyalya-Volga section through Solikamsk, and a number of others.

Maps showing the construction conditions and indicating the competitive routes were compiled after synthesizing special cartographic materials. These maps reflected the ground conditions in the construction area, the moisture content of the ground and the height of the water table, all of which influence the workability of the ground and the passability of construction equipment. These materials made it possible to objectively evaluate the work rate of integrated production teams in different natural and climatic regions of construction and in different times of the year, and to determine the most complex sections of the route.

The periods in which construction could realistically be conducted in marshes and in flooded sections were determined by computer prediction of the degree of freezing of marshes that would be sufficient to permit movement of transportation resources.

As each variant was substantiated the labor outlays on construction of the linear part of the pipeline and the above-ground structures were determined, problems associated with the construction organization were studied, the basic transportation routes were developed, the demand for production teams was determined, and relocation plans were created.

The southern variant was recognized to be the optimum variant for the export gas pipeline route.

The institute took an active part in developing the concrete organizational and technical measures associated with the preparatory and main periods of construction of the Urengoy-Pomary-Uzhgorod gas main. After the deadline for the gas pipeline's commissioning was officially approved, the directive and working construction schedules, the schedule for relocating production teams from the corridor containing the Urengoy-Petrovsk and Urengoy-Novopskov gas pipelines to the Urengoy-Pomary-Uzhgorod corridor, and the basic concepts associated with organizing construction of the gas pipelines were developed. The master plan for construction of the gas pipeline was examined in detail, and the plan quotas for construction of the export gas main were determined for the production teams, trusts, main production administrations and associations.

Special logs were created to monitor the construction process and to permit party, soviet and social organizations of the oblasts and autonomous republics through which the gas pipeline passed to provide efficient assistance.

The Urengoy-Pomary-Uzhgorod gas main is a unique facility in terms of its production and construction parameters. This necessitated review of the traditional methods of construction and its organization.

A new way of improving the quality of production planning documents was found during development of the organizational plan for construction of the gas pipeline.

The organizational plan of construction of the Urengoy-Pomary-Uzhgorod gas pipeline was drawn up in its general form on the basis of the measures developed and approved by each main construction administration. Thus the production organizations and the services of the ministry and the planning technological institutes were immediately included in the effort to solve the organizational problems of construction. Constant ties are being maintained with planning institutes and services of the Ministry of Gas Industry. One of the important directions of improving the organizational plan of construction will be to introduce a new independent section reflecting the organizational, economic, social, psychological and legal preparations in support of construction.

A sector organizational plan was drawn up for construction of compressors stations in the 11th Five-Year Plan. It spells out the material and technical resources required to erect compressor stations, broken down in relation to the main administrations and for the ministry as a whole. It also indicates the starting dates for the preparatory and main periods of construction, and the optimum production decisions.

Directive schedules were drawn up for introduction of compressor stations erected by CEMA countries. These schedules spelled out the stages of construction, which were based on the schedule for delivering the main production equipment.

The sector organizational plan of construction for 1983 drawn up by the institute devotes special attention to construction of 10 priority compressor stations along the Urengoy-Pomary-Uzhgorod gas pipeline. Planning schedules for producing the assembly modules were drawn up, and the basic premises concerning organization and construction of compressor stations were determined.

The transportation scheme proposed by the NIPIorgneftegazstroy determined the volume of cargo deliveries that would be balanced by the unloading possibilities of the railroad stations. The list of the latter was coordinated with the railroad administrations. Recommendations were developed on building sidings, unloading platforms and approach roads.

The NIPIorgneftegazstroy is participating in a number of specific-purpose scientific-technical production programs, implementation of which is promoting successful construction of the export gas pipeline.

The NIPIorgneftegazstroy has been given the responsibility of coordinating the work of the Orgtekhstroy trusts of the Ministry of Construction of Petroleum and Gas Industry Enterprises.

In accordance with the specific-purpose program of the Ministry of Construction of Petroleum and Gas Industry Enterprises, the Orgtekhstroy trust of the Glavyuzhtruboprovodstroy [not further identified] developed the complete work plans for the Krasnodartruboprovodstroy and Rostovtrubopovodstroy trusts, taking account of the requirements imposed on organization and the procedures of high-speed flow-line construction of main pipelines. Plans were drawn up for long-term field base camps for this route in the settlements of Okhochevka, Sudzha and Dolgoye.

The introduction group of the Orgtekhstroy trust of Glavyuzhtruboprovodstroy provided assistance in developing, for the Rostovtruboprovodstroy and Stavropol'truboprovodstroy trusts, the organization and procedures of work using the "Styk" welding equipment complex.

The Orgtekhstroy trust of Glavukrneftegazstroy [not further identified] has also developed a number of work plans. Special attention was devoted to construction in the complex conditions of the Carpathians.

The work plan developed by the Orgtekhtruboprovodstroy trust of Glavsibtruboprovodstroy [not further identified] examines the organization and construction of the initial section of the gas pipeline. Special attention is devoted to excavations in permafrost sections, to the use of a "Sever-1" device to weld piping into a strand, to the particular features of working with pipes insulated at the plant and to protecting the environment.

Unification of planning and scientific research subdivisions in the NIPIorgneftegazstroy institute promoted growth in the technical and economic level of the work done.

The institute's scientific laboratories have calculated the economic effectiveness of reducing the time of construction of the export main.

Jointly with the YuzhNIIgiprogaz [not further identified] and the Glavsibtruboprovodstroy, recommendations were developed on using heat-insulating shields for erection of the Urengoy-Pomary-Uzhgorod gas pipeline in the permafrost zone.

A map of the conditions for construction of the gas pipeline in the Urengoy-Ivdel section, presently being compiled, is a synthesis of a number of permafrost maps of the West Siberia plate drawn up by Moscow State University, working drawings and the results of multivariant computer forecasts of the dynamics of seasonal ground thawing-freezing related to different construction conditions. This map will make it possible to predict the change in geological engineering conditions during subsequent construction of parallel gas pipelines, and to substantiate the special requirements on the design concepts associated with gas pipelines laid in a permafrost zone. A specific-purpose integrated program aimed at improving the economic mechanism of the Ministry of Construction of Petroleum and Gas Industry Enterprises was drawn up with the participation of the NIPIorgneftegazstroy. This program foresees scientific, methodological and normative support to organizing the sector, training personnel for new management methods, conducting extensive economic experiments and developing and introducing a system of measures for stage-by-stage alteration of the sector's economic mechanism.

A certain amount of work has already been done in this area. The Ukrtruboprovodstroy trust of the Glavukrneftegazstroy and the Transcaucasian Administration of Pipeline Construction (ZUST) of the "Soyuzintergazstroy" association have been converted to planning labor productivity and paying wages on the basis of the standard conditionally net product indicator. A year and a half of the work experience of these organizations attests to the effectiveness of the new indicator of labor outlays and of creating objective conditions permitting clearer orientation of production collectives toward attaining the end results of construction--planned introduction of productive capacities and facilities coupled with raising labor productivity and improving the use of fixed capital. The Ukrtruboprovodstroy trust increased the quantity of pipelines placed into operation by 25 percent, while the total volume of finished construction increased by more than 2.7 times. In the ZUST the pipeline introduction indicator increased by 63 percent. Annual wages increased by an average of 43 percent in these organizations, and the average time of erection of main pipelines decreased by almost 15-20 percent.

One of the most important directions of improving the economic mechanism is to intensify the material and moral stimuli of the labor of the sector's production collectives and organizations. A number of integrated production teams are participating in an experiment in which piece-work wages are being paid on the basis of a single work order calling for a flow-line contract. The indicator used in determining wages is the number of kilometers of welded, insulated and buried pipeline after recultivation of the soil.

The experimental production teams increased the rate of pipeline erection by 1.5-2 times (20-25 km per month) in comparison with the rates achieved prior to the conversion to the flow-line method. The wages per worker of a production team increased by an average of 35-40 percent. Differences in the wages received by workers of different categories were smoothed out, and the tendency toward completing jobs using fewer people and toward combining worker occupations was intensified.

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CENTRALIZED SPECIFIC-PURPOSE PLANNING, CONTROL SYSTEM APPLIED TO GAS PIPELINE

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[Article by A. S. Shchenkov, GIVTs, Minneftegazstroy: "Specific-Purpose Program Methods in the System of Operational Planning and Control of Construction of the Urengoy-Pomary-Uzhgorod Gas Pipeline"]

[Text] The country's petroleum and gas complex is developing at a rapid rate. The Minneftegazstroy [Ministry of Construction of Petroleum and Gas Industry Enterprises] is concentrating its efforts on increasing the rate of erection of the facilities of petroleum and gas industry, and on all-out economization of labor, material, technical, financial, fuel and power resources on the basis of reequipment and improvement of the sector's economic mechanism.

A specific-purpose program for introducing superhigh-capacity gas transport systems extending from Siberia to the country's center and abroad was developed for the first time in our sector for the current five-year plan.

Considering the large scale of the tasks facing the ministry, the sector is using fundamentally new forms of organizing pipeline and station construction, based on a transition from specialization in relation to types of jobs to specialization in relation to phases of construction, such that all forms of resources and organizational structures are integrated and the role of primary production collectives is augmented.

This is a decisive factor of hastening the rate of erection of main pipelines, of achieving successive growth of labor productivity and production quality, and of establishing the strictest possible economization practices in all units of the construction conveyor.

High-output production subdivisions involved in engineering preparations for construction, in road building and transportation operations, in integrated fulfillment of the main jobs and in providing services and auxiliary operations are being created. Thus a high rate of completion of the main pipeline laying operations by integrated production teams must be insured through anticipatory completion of technologically complex sections, through timely delivery and positioning of pipe sections and reinforced concrete weights along the route, through maintenance of an adequate reserve of the main types of machines and mechanisms and through high quality and efficient equipment repair.

The new forms of organizing pipeline construction require appropriate alteration of the existing system of operational planning and control in the sector. Use of the specific-purpose program approach will make it possible to effectively combine the principles of sector, intersector and territorial control.

It may be said that we already have a system for controlling erection of the key construction projects of the five-year plan, one consisting of specific-purpose control organs reaching from the level of the primary production collectives to the ministry's administrative machinery. These are not supplementary, independent control organs, but specific-purpose administrative structures formed and functioning within the framework of the sector's existing control system.

Analysis of the function of the planning and control system used during erection of the Urengoy-Gryazovets-MOK [Moscow Oblast Committee], the Urengoy-Petrovsk, and the Urengoy-Novopskov gas pipelines showed that the production organization decisions adopted within it basically justified themselves. The matrix form of organizing the planning and control of the erection of the most important facilities practically demonstrated its high effectiveness in insuring completion of national economic tasks. These gas pipelines were placed into operation significantly ahead of the standard construction schedule.

Information support provided to the control system and the quality of and the efficiency with which the necessary data were furnished to the management continued to improve at these facilities. The effectiveness of the control system was raised significantly owing to division of the whole construction process into organizational, preparatory, main and concluding phases, and to creation of local independent information systems within the general system with a consideration for the particular features of each of these phases.

But many problems still remain unsolved.

The necessary unity of all control organs, both administrative and functional, ranging from the level of the production teams to the ministry level, was not attained. The system for analyzing construction progress and preparing decisions in response to deviations was not fully realized. The causes behind delays, the characteristics of the meteorological conditions at the construction sites and data on measures adopted to correct deviations were absent from the information on work progress. A statute on construction staffs was not written. The composition of staff workers is constantly changing. The qualifications of many individuals appointed to construction staffs do not satisfy the requirements of the operational control system.

The technical base of the operational control system is in an unsatisfactory state. The existing communication lines cannot fully support the needs of the service. There is not enough apparatus to outfit the regional and rayon construction staffs. Computer technology is being used little and with inadequate effectiveness. Technical resources are dispersed among various organizations, which hinders creation and operation of a unified technical base for the control system.

The system for operational planning and control of the erection of pipelines within the same energy corridor must be interpreted as a specific-purpose system. It must promote fulfillment of its main purpose--insuring unconditional completion of construction and installation jobs associated with erection of the entire system, to include the linear part of the gas main, the underwater crossings, the compressor stations, and the housing, social, cultural and personal services facilities, all within the deadlines established by the directives and with effective use of labor, material, fuel, power, technical and financial resources and high quality of the end product.

This system must insure effective completion of control tasks in all phases--organizational, preparatory, main and concluding.

A technical work plan was created as a basis for organizing and operating the specific-purpose system of operational planning and control of construction of the Urengoy-Pomary-Uzhgorod gas pipeline.

The plan was drawn up with a consideration for the experience of organizing operational control during erection of the Ust-Balyk-Kurgan-Almetyevsk petroleum pipeline and the Vyngapur-Chelyabinsk, the Urengoy-Chelyabinsk, the Urengoy-Gryazovets-MOK, the Urengoy-Petrovsk and Urengoy-Novopskov gas pipelines.

The system for controlling construction of the Urengoy-Pomary-Uzhgorod gas pipeline has a number of unique features. A large number of the national economy's sectors and numerous republic and oblast industrial enterprises are taking part in the main's erection. This requires coordination of the effort at the intersector and interregional level, and examination of both the problems associated with direct participation of organizations belonging to other construction ministries in construction of the gas pipeline, and problems associated with supporting the construction. Participation of CEMA countries in erection of the gas main also requires the control system to address the problems associated with its integration policy.

Problems of this sort have arisen to varying extents at various construction projects in previous five-year plans, but this is the first time that they are being resolved together in a single construction project.

The sector's organizations are completing their work on previous pipeline strands and rebasing themselves for construction of the export gas main right during construction of the Urengoy-Pomary-Uzhgorod gas pipeline. Thus the object of control is represented by three gas mains being erected simultaneously and existing in different phases of construction (preparatory, main and concluding).

During the planning of jobs to be conducted within the single energy corridor, a plan was drawn up for the first time for organizing construction at all pipeline strands. This plan includes a program for relocating production collectives from one route to another. In addition, the system of operational planning and control faces the task of planning the maneuver of resources during construction of a single gas pipeline and implementing such plans. This task arose in connection with the increase of the work rate at sections

being erected by primary production collectives belonging to new formations that are specialized in relation to the different phases of construction. To raise the effectiveness with which the output capacities of mobile integrated subdivisions are being used, concrete relocation procedures are being developed and the sensible magnitude of the maneuver of manpower and construction equipment is being determined.

Formation of a sector data bank containing information on construction progress and on the causes of arising deviations from the planned quotas is a fundamentally new task. These data banks will be used in the future to support long-range planning and forecasting.

The organizational role of the input and output forms of operational information has risen. The practice of previous construction projects persuasively demonstrated that if the form in which information is sbumitted accounts for the particular features of the region in which the work is proceeding, and for the rate of construction, the information does play an active role in resolving the problems of specific-purpose programs. During the time when operational information did not reflect the progress in each concrete form of construction, and instead contained only general data on the given form of construction, the state of affairs at the facilities under construction remained unsatisfactory. In order that the forms in which operational data was to be presented could be made more concrete, document handling on a local basis had to be worked out carefully, and the specific quotas for each facility had to be revealed and defined. This promoted better quality of work on the route as a whole.

A subsystem supporting phase-by-phase introduction of the gas pipeline was created within the specific-purpose system for controlling erection of the Urengoy-Pomary-Uzhgorod main. This made it possible to attain a sizeable economic impact from early commissioning of individual sections of the export gas pipeline--a prerequisite of improving the operating conditions of the existing gas transport system, and to devise a sensible schedule of work in the concluding phase for the route as a whole: The pipeline testing processes were distributed over time.

Let us examine the particular features of this system of operational planning and control of construction of the export gas main.

The specific-purpose system of operational planning and control is formed for the period of erection of the gas pipeline out of existing organs belonging to the traditional administration (the administrative machinery of the ministry, the main production administration, the trusts and the construction administration). It consists of four control levels: the construction project as a whole, the construction region, the construction rayon and the construction section.

A central construction control staff consisting of workers from the GlavPRU [Main Production Management Administration] and of Operating Main Administrations, representatives of the client and, as a supporting unit, workers of the Minneftegazstroy's GIVTs [Chief Information and Statistical Center] was created at the

level of the construction project as a whole. It functions in all phases of construction. The specific purpose of the staff is to resolve, on an operational basis, problems associated with supporting construction and commissioning the gas pipeline with high quality and by the established deadlines.

At the level of each construction region a regional staff is created, consisting of workers of main territorial production management administrations (GlavterPRUs), representatives of the functional main administrations, representatives of the client and of contracting ministries and departments, and representatives of local party and soviet organs. The regional staff coordinates the work, and it solves, on an operational basis, problems connected with supporting construction and commissioning individual parts of the gas main, to include the compressor stations, within the given region.

A special staff is also created at the construction rayon level. It is formed out of workers from the administrative machinery of the main production and functional administration, and representatives of local govenrment organs. It resolves, on an operational basis, problems associated with supporting construction and commissioning facilities of the gas main within the given rayon.

An information and control point is created for each specialized production team within each construction section--mobile mechanized columns specialized in road building, transportation and engineering preparations, and the integrated production team responsible for the principal-job--as well as at the construction sites of the compressor stations and crossings over navigable rivers. The trusts and construction administrations form such points and provide the necessary manpower and technical resources.

The production team information and control point resolves, on an operational basis, problems associated with supporting construction and installation jobs and commissioning the particular facility assigned to the production team.

Monthly and weekly-daily planning: Operational planning is the principal functional unit of the specific-purpose system for controlling erection of the Urengoy-Pomary-Uzhgorod pipeline.

The following are drawn up within the framework of the specific-purpose system of operational planning and control: a specific-purpose directive schedule for construction of the linear part of the pipeline and for erection of crossings over navigable rivers and of compressor stations; a monthly work planning schedule; daily-weekly quotas.

The specific-purpose directive schedule is the foundation for writing the monthly work planning schedules for the main production administrations, associations, general contracting trusts and production teams.

Subdivisions of the GlavPRU and GIVTs of the Minneftegazstroy calculate and correct the monthly planning schedules on the basis of the work remaining as of the beginning of the planning period and the directive termination deadlines.

Weekly-daily planning is the basis for the function of the specific-purpose operational control system. It must account for the production situation that has evolved at a facility at a given moment, and it must establish concrete immediate goals, fulfillment of which would insure attainment of the results spelled out by the monthly planning schedule.

Weekly-daily planning must proceed from bottom up. The initiative of setting the weekly-daily quotas belongs completely to the production teams. They must suggest and substantiate their proposals before the trust and staff of the construction rayon. After the weekly-daily plans for the trusts and for the main administration as a whole are coordinated and generalized, they must be submitted to the central construction control staff. Their final coordination and approval are the responsibility of a project-wide selection conference.

The planning week used in setting the weekly-daily quotas goes from Monday to Sunday inclusively. Quotas for the following week are reported by the rayon construction staffs to the central staff in the appropriate format, broken down in relation to the different production teams, the general contracting trusts and the rayon as a whole. The quotas must be submitted on Mondays prior to 1000 hours Moscow time. Draft quotas for the planning month, broken down into weeks, are submitted to the central staff for coordination on the last Monday of the month preceding the planned month. The monthly quota must contain three indicators in relation to each form of work planned (total, main quota, supplementary quota). The supplementary quota is used for adjustment purposes, and it accounts for work not finished in satisfaction of the previous month's quotas. The results of fulfilling daily quotas are reported by the production teams to the trusts and the construction rayon staffs, as well as to the central staff in accordance with the appropriate schedule.

The production teams report their results of fulfilling weekly quotas to the trusts and construction rayon staffs, while they in turn report these figures to the central staff on Mondays of the current week, together with the results of fulfilling Friday's daily quota.

Information support must be provided to organs of the specific-purpose operational planning and control system in conjunction with the daily, weekly and monthly cycles of the system's function.

Operational information provided in conjunction with each cycle of the system's function may be regular (formalized) or irregular (provided on demand, emergency information). Its composition changes depending on the phase of the construction process--preparatory, main or concluding.

The information provided is categorized in relation to levels of control, phases of construction, facilities under construction, monitored positions, types of jobs and forms of supply, and it is submitted on forms that are standard for all levels of control.

Primary, analytical, planning and normative-reference data banks must be foreseen for accumulation and storage of information with purpose of its

subsequent analysis, forecasting of work progress at a facility and generalization of the best experience at all control levels. The principal pooled data of these banks must be recorded in the log of the pipeline construction complex.

The specific-purpose control system operates on the basis of three fixed functional cycles.

The monthly cycle entails collection, processing and transmission of analytical information on construction progress and on material, technical and labor support in the previous month, and development and approval of monthly plans broken down into weeks at the level of the integrated production teams, the complexes responsible for construction of compressor stations and crossings over navigable rivers, the construction rayon and the construction region, and the construction project as a whole.

The weekly cycle entails collection, processing and transmission of analytical information covering the previous week, analysis of the evolved production situation, prediction of its development, and development and approval of weekly-daily quotas at selection conferences. The levels addressed in this cycle include the central staff, the rayon and regional staffs, and the integrated production team or the complex responsible for construction of compressor stations and crossings over navigable rivers.

The daily cycle entails collection, processing and transmission of information, at all levels of control, on work progress achieved on previous days by the integrated production team and by the complex responsible for construction of compressor stations and crossings over navigable rivers.

Primary and current awareness information is transmitted via the information and control point to the information and control point of the construction rayon staff, and to the trusts. At the construction rayon staff the data are generalized and then transmitted to the control division of the GIVTs, to the appropriate main administrations and to the regional GlavterPRU. Information processed at the GIVTs is transmitted to the GlavterPRU and the central construction control staff. Management decisions made at the level of the central staff are brought to the awareness of the executors.

Selection conferences concerned with erection of the Urengoy-Pomary-Uzhgorod gas pipeline are conducted as part of the weekly operational planning and control cycle. Specific conferences are concerned with pipeline construction and with erection of compressor stations, residential buildings and cultural and personal services facilities.

Selection conferences embrace all levels of control--production teams, compressor station construction complexes, construction rayon staffs, GlavterPRU and the central staff. They are organized and conducted by workers of the specific-purpose control system's information and control service.

The central control division and the control divisions of the administrations, associations and trusts maintain daily control over implementation of

instructions and decisions adopted at selection conferences, and they systematically inform the appropriate executives on progress on fulfilling these instructions.

Within a day after a selection conference the executives of main administrations and associations send the minutes of these meetings to the Main Production Management Administration.

Effective function of the specific-purpose control system requires the support of modern technical communication, data transmission and information processing and duplicating resources.

The information and control points of production teams and compressor station construction complexes must be equipped with resources permitting the controller to communicate with each brigade (column), with the main material-technical and repair services, with the controllers of other production teams and with the construction rayon staff.

The construction rayon staff must be supplied with technical resources permitting the staff chief and the controller to communicate with the information and control points of the production teams, the Main Territorial Production Management Administration, the central staff and local government organs.

Technical resources for processing and transmitting information through the network of interlinking communication channels must also be broadly employed in this area.

The central staff must have technical resources providing communication with the main territorial production management administrations, the construction rayon staffs, the organizations supplying structural parts, the client and higher control organs. Information is processed at this level by YeS-1033 computers, TAP-34 intelligent terminals, TAP-2 and TAP-3 units for transmitting information through interlinking communication channels, and various office equipment.

Creation of an "Informneftegazstroy" production association out of existing computer centers and communication enterprises has been proposed as a means for improving the function of the specific-purpose operational planning and control system.

The main task of such an association would be to provide information support to the sector operational control system. It would provide services to the sector's production organizations and to the specific-purpose control organs, such as subjecting construction progress data to integrated processing using modern communication, data transmission and computer resources. Concentration of the technical resources used for data collection, transmission and processing within a single organization would make it possible to simultaneously provide consumers with the planning, statistical and analytical materials they require.

A single automated data base that stores information, issues analytical summaries on a regular schedule and in response to specific requests, and performs the procedures associated with operational planning, short-term forecasting and adoption of grounded management decisions should be created within the framework of the "Informneftegazstroy" association. Creation of such a base would make it possible to provide the specific-purpose control organs with necessary and sufficient operational information on construction progress, on the causes of deviations from the schedule and on the availability of manpower, machines, mechanisms, construction materials and structures; analytical information on construction progress in the system as a whole and in relation to specific regions, rayons, krays and oblasts; information on issues requiring decisions at the appropriate control levels, and on the results of monitoring their implementation.

The sector system for operational planning and control in the Minneftegazstroy is being developed on the basis of a program of scientific-technical cooperation with multiple-user information and computer centers, the VNIIST [All-Union Scientific Research Institute for the Construction of Main Pipelines], the Kiev affiliate of the VNIIST, the VNIPIorgneftegazstroy [not further identified], the Institute of Cybernetics imeni V. G. Glushkov of the Ukrainian SSR Academy of Sciences, the IPK [Underground Communications Engineering] of the Minneftegazstroy and other organizations.

Further development of the operational planning and control system will proceed in stages, in relation to individual specific-purpose subprograms. In the future all petroleum and gas facilities under construction will fall under the sector system for operational planning and control. Much attention will be devoted to the planning and control of material-technical support to construction, and primarily to the supply of piping, reinforced concrete weights, spare parts for imported equipment, connecting parts, valve fittings and other materials.

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DIFFERENT DESIGN VARIANTS OF UNDERWATER GAS PIPELINE CROSSINGS ANALYZED

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 1, Jan 83 pp 16-18

[Article by A. Ya. Yermolin, "Soyuzpodvodtruboprovodstroy" VSMO, and S. I. Levin, VNIIST: "Erection of Underwater 1,420 mm Diameter Crossings in the West Siberia-Center Gas Pipeline System"]

[Text] The most difficult and laborious part of building high-capacity gas pipelines is construction of underwater crossings over water obstacles.

The difficulty of building underwater crossings for the West Siberia-Center multistrand system lies not only with the greater volume of the work and its unique features but also with the need for cutting the work schedule without increasing the number of personnel employed by the construction organizations.

A complex of measures aimed at organizational improvement of specialized organizations building underwater crossings was developed and implemented. The design concepts and construction procedures were improved as well.

The main organizational measures included creation of the "Soyuzpodvodtruboprovodstroy" VSMO [All-Union Construction and Installation Association] in the Minneftegazstroy [Ministry of Construction of Petroleum and Gas Industry Enterprises], which includes two trusts for the construction of underwater crossings in the central region and in Siberia.

Improvements in the structure of organizations of Minneftegazstroy specializing in construction of underwater obstacles resulted in a 147 percent increase in the volume of construction and installation operations and a 150 percent increase in finished construction in 1982.

The VSMO possesses highly productive equipment capable of digging underwater trenches in any kind of earth, including heavy earth, at depths of 20-25 meters.

Organization of a mechanization administration within the VSMO has made it possible to efficiently relocate excavating equipment to facilities under construction, and it has promoted an increase in the use coefficient of this equipment.

Pipeline strands are assembled at an assembly base and then towed to the underwater crossings under construction. This has been found to be an

effective method. Its use together with high-power excavating equipment made it possible to complete construction of an underwater two-strand crossing over the Kama River on the Urengoy-Pomary-Uzhgorod route in 1982 within a single navigation season, rather than in the 2 years allowed by the plan, and to increase labor productivity by 120 percent.

Introduction of piping 1,420 mm in diameter to construction of underwater crossings and optimization of planning decisions concerned with creating back-ups and raising the dependability of underwater gas pipelines at crossings of the multistrand West-Siberia-Center system are of special significance in the "Integrated Measures for Improving the Procedures and Raising the Rate and Quality of Construction of Underwater Crossings," written and approved by the administration of the Minneftegazstroy.

Use of piping with a diameter of 1,420 mm reduces the number of pipelines that must be laid, and it excludes the need for using shore-based chambers for removing and introducing cleaning devices, the cost of which may exceed the cost of the underwater gas pipeline itself at crossings of short length. By laying piping with a diameter of 1,420 mm, which has an internal diameter equal to that of the piping of the gas main, we can significantly improve the operating conditions and reduce the volume of excavating operations by 40 percent.

Construction of underwater gas pipelines with a diameter of 1,220 mm was initiated in the 10th Five-Year Plan. Piping with a diameter of 1,220 mm was laid at nine (out of 11) crossings of the Vyngapur-Chelyabinsk gas pipeline route. This reduced the outlays by 1.8 million rubles in comparison with the cost of laying gas pipelines with a diameter of 1,020 mm. In 1978 respectively 43 and 12 km of 1,020 and 1,220 mm diameter underwater piping were laid, while in 1982 the figures were 30 and 35 km; the length of 1,420 mm underwater gas pipeline was 10 km. The volume of construction and installation associated with construction of underwater crossings increased from 60 to 90 million rubles between 1977 and 1982.

Construction of underwater crossings out of piping with a diameter of 1,420 mm is complicated by its greater flexural rigidity and weight, as well as by the need for raising the reliability of the pipelines.

Flexural rigidity increases in proportion to the product of the cube of the pipeline diameter and wall thickness. As rigidity increases, the amount of weight required to hold down a bent section increases. In the straight section of a crossing, the amount of weight required would increase in proportion to the square of the diameter.

The weight of a 1,420 mm diameter pipeline with its weights attached (or with a concrete coating) would be 30 percent greater than the weight of a 1,220 mm diameter pipeline, and 75 percent greater than the weight of a 1,020 mm diameter pipeline. Correspondingly with an increase in weight, the pipe assembly and laying operations grow more complex; lifting resources of higher capacity are required.

The design concepts applicable to 1,420 mm diameter underwater gas pipelines are being reviewed in conjunction with the possibility for reducing back-up strands at crossings. Retention of the existing and insufficiently substantiated requirements on laying back-up strands over any water obstacle more than 75 meters wide (SNiP [Construction Norms and Regulations] II-45-75) coupled with a simultaneous increase in pipe diameter will lead to greater outlays and longer crossing construction time. However, reduction of back-up strands must not decrease the dependability of gas transport, which would be possible only if the underwater pipelines are laid dependably.

An analysis of failures of underwater pipelines in the last 20 years revealed the main causes of pipe damage: pipes not buried deeply enough, resulting in fatigue stresses in sagging sections; inadequate control over welding operations, and others.

In recent years research was conducted and measures were implemented aimed at insuring dependable operation of underwater pipelines. Pipes of higher quality satisfying the requirements of SNiP II-45-75 (Paragraph 13.18) are used in crossings. As a result of many years of research by the State Hydrological Institute (GGI) jointly with the VNIIST [All-Union Scientific Research Institute for the Construction of Main Pipelines], the procedures of accounting for riverbed deformations were developed and recommendations were provided. Control of welding operations was improved.

Analysis of the causes behind failures of underwater pipelines led to the following conclusions: The strength of piping manufactured in accordance with the existing norms and supplied in accordance with their requirements is sufficient to resist loads arising in the course of a crossing's normal operation; requirements on anticorrosion protection insure dependable operation of a crossing for its prescribed period of operation; the ballast requirements imposed on them (in application to cast iron weights) are sufficient to prevent surfacing of the riverbed sections of the crossings. These conclusions served as the basis for developing a classification of the underwater crossings of a multistrand gas pipeline system. It was suggested that all crossings of the gas pipeline system be divided into five groups: group I--across water basins and rivers more than 750 meters wide at low water (for the West Siberia-Center gas pipeline system these would include the crossings over Kuybyshevskoye Reservoir, the Volga and the Ob'); group II--across water obstacles 250-750 meters wide; group III--across rivers from 75 to 250 meters wide; group IV--across rivers from 30 to 75 meters wide; group V--across rivers up to 30 meters wide.

The Urengoy-Pomary-Uzhgorod route will require construction of 4 group I crossings, 5 group II crossings, 12 group III crossings, 9 group IV crossings and 762 group V crossings. The group I and II gas pipeline crossings are planned to be underwater crossings, while group IV crossings are to be underwater and above-water crossings. As a rule, the above-water design is the most economical for group V crossings.

Piping with a diameter of 1,420 mm has been recommended for group III, IV and V crossings. Gas pipelines with a diameter of 1,420 mm may be planned for

group I and II crossings under favorable local conditions, assuming mandatory preliminary coordination (prior to developing the working drawings) with the construction organization, with regard for the technical resources available to it.

It is recommended that group III, IV and V gas pipeline crossings be planned without back-up strands (according to SNiP II-45-75 such a decision can be made only for group IV and V crossings).

Laying one common back-up strand with a diameter of 1,220 mm for every two gas mains of a multistrand system is recommended for group I and II crossings for which the decision has been made, and coordinated with the construction organization, to lay piping with a diameter of 1,420 mm. In this case shut-off valve fittings must be installed on each underwater gas pipeline, and connectors must be installed between the strands at both boundaries of the crossing.

Different variants of underwater gas pipeline design can be used in the construction of a crossing out of 1,420 mm diameter piping (see Table). Gas pipeline weight was calculated in relation to a straight riverbed section using SNiP II-45-75.

Design Variants of 1,420 mm Diameter Underwater Pipelines and Their Characteristics

(1) №№ вариантов	(2) Конструкция подводного газопровода 1420×19,7 мм с балластом	(3) Масса 1 м газопровода с балластом		(5) Металлоемкость на 100 м				(8) Затраты труда (на 100 м трубопровода)		(10) Стоимость основных работ (на 100 м трубопровода)	
				(6) Сталь		(7) Сталь+чугун					
		(4) кг	%	кг	%	кг	%	(9) чел.-дни	%	(11) тыс. руб.	%
I	Балластировка чугунными грузами, $\gamma_ч = 7,15$ т/м³ (12)	2360	100	64,7	100	230,7	100	239,4	100	60,4	100
IIа	Балластировка кольцевыми железобетонными грузами, $\gamma_б = 2,4$ т/м³ (13)	3320	140,7	64,7	100	64,7	28	114,8	48	50,7	83,9
IIб	То же $\gamma_б = 3,0$ т/м³ (14)	2995	122,2	64,7	100	64,7	28	101,4	42,3	45,6	75,5
III	Балластировка кольцевыми грузами из литого шлака, $\gamma_б = 3,0$ т/м³ (15)	2995	122,2	64,7	100	64,7	28	101,4	42,3	39,4	65,2
IVа	Сплошные железобетонные покрытия труб, $\gamma_б = 2,4$ т/м³ (16)	2810	119,1	64,7	100	64,7	28	34,3	14,3	40,2	66,6
IVб	То же, $\gamma_б = 3,0$ т/м³ (14)	2550	108,1	64,7	100	64,7	28	34,3	14,3	40,2	66,6
V	Обетонирование трубопровода в съемной опалубке $\gamma_б = 2,2$ т/м³ (17)	3165	134,1	64,7	115,4	64,7	28	291,2*	121,7	56,6	93,7
VI	Конструкция «труба в трубе» с песчано-цементным заполнением кожух-труба 1720×16 мм (18)	2870	121,6	64,7	203,9	203,9	88,3	303,4	126,7	72,8	120,5

* Labor outlays were calculated with a consideration for the fact that concrete would be prepared at the construction site

Key:

1. Variant number
2. Design characteristics of a ballasted 1,420×19.7 mm underwater gas pipeline
3. Weight of 1 meter of ballasted gas pipeline
4. kg
5. Metal content per 100 meters
6. Steel
7. Steel plus iron
8. Labor outlays (per 100 meters of pipeline
9. Man-days
10. Cost of principal operations (per 100 meters of pipeline)

[Key continued on following page]

11. Thousands of rubles
12. Ballasted with cast iron weights
13. Ballasted with reinforced concrete weights
14. As above
15. Ballasted with cast slag circular weights
16. Piping with continuous reinforced concrete coating
17. Pipeline encased in concrete using a removable form
18. "Pipe within pipe" design, with 1,720×16 mm sheathing pipe filled with sand-cement mixture

All of the examined design variants use a 1,420×19.7 mm working pipeline intended to transport gas at a pressure of 7.5 MPa. Piping made from Kh70 steel with a tensile strength of 600 MPa and a yield point of 470 MPa corresponds to the high requirements of SNiP II-45-75 and exhibits sufficient strength to resist the factors to which an operating underwater crossing is subjected.

Variant I--a 1,420×19.7 mm underwater gas pipeline ballasted with cast iron weights, buried in the floor of the water basin below the level of its possible deformations and having an anticorrosion coating and lining--was adopted as the standard for comparison of different engineering concepts. The "Soyuzpodvodtruboprovostroy" VSMO must build 20 such crossings on the Urengoy-Pomary-Uzhgorod route. The weight of a gas pipeline ballasted with cast iron weights is less than that of the other designs examined here. This facilitates their laying, and it provides a possibility for separate transportation of pipes and weights to remote regions by air.

Variant IIa was used in June 1982 to build one of the crossings of the Urengoy-Novopskov gas pipeline.

The experimental lot of prefabricated reinforced concrete circular weights was manufactured at a plant in Apsalyamov on the basis of a plan drawn up by the Reinforced Concrete Experimental Design Office using recommendations of the VNIIST.

The Vostoktruboprovodstroy trust, which built the crossing, installed 150 outfits of reinforced concrete weights on two bundles of pipeline 170 and 130 meters long. UTK reinforced concrete weights and cast iron weights were installed on one bundle. The labor required to install type UTK reinforced concrete weights did not exceed that required to install cast iron weights of the same diameter. When the ballasted gas pipeline bundle was dragged into place with a traction force of up to 1,300 kilonewtons, shifting of the weights along the pipeline was not observed. UTK-1420-1 reinforced concrete circular weights were recommended for series production on the basis of the results of the experimental effort.

As the density of the material used to make reinforced concrete weights increases, the weight of the pipeline structure decreases and correspondingly the pipeline assembly and laying operations become easier.

Experimental cast slag weights with a density of 3.0 tons/m^3 that satisfied the gas pipeline ballasting requirements were manufactured for variant III.

Continuous reinforced concrete coatings were used on gas pipelines with a diameter of 1,020 mm laid across channels in the floodplain section of the Ob' crossing of the Vyngapur-Chelyabinsk gas pipeline. The pipes were encased in concrete at an experimental base in Surgut. Pipelines with a diameter of 720 mm encased in concrete at the Baku plant of the Ministry of Gas Industry were laid at the Volzhskoye Reservoir crossing of the Urengoy-Petrovsk route.

The decrease in weight of a gas pipeline with a continuous concrete coating having a density of 3.0 tons/m^3 (2,550 kg/m) in comparison with the weight of a gas pipeline ballasted by concrete (slag) weights having a density of 3.0 tons/m^3 (2995 kg/m) can be explained by elimination of the wooden lining from the former case.

In July 1982, during construction of one of the crossings of the Urengoy-Novopskov route, an underwater gas pipeline section 300 meters long was encased in concrete using a form (made from sheet steel 2 mm thick) proposed by specialists of the Vostokpodvodtruboprovodstroy. Steel sheets 1,440 mm wide were wrapped around the pipes and rested on foundation blocks that secured the position of the reinforcement metal network. The sheets were tightened together above by bolts. The concrete mexture was poured into an upper slit 0.7 meters wide. "Dry" concrete mixture was delivered to the crossing construction site by cement trucks from a concrete plant located 32 km away. The monolithic concrete coating, which had a density of 2.2 tons/m^3 and an average thickness of 230 mm, was interrupted by slits 0.3 meters wide spaced 10-11 meters apart along the length of the pipeline.

The work demonstrated that a brigade of seven persons can encase up to 30 meters of pipeline in concrete within a single shift (this is not counting the labor outlays on preparing and transporting the concrete mixture).

Variant VI--the "pipe within pipe" design in which the outer pipe is filled with a sand-cement mixture--was developed by the Giprospetsgaz [not further identified] institute. An experimental crossing with such a design is to be built in 1983. There are plans for using 1,720×16 mm steel piping as the outer sheathing, and for filling the space between the pipes with a sand-cement slurry having a density of 1.9 tons/m^3. According to the recommendations made by specialists of the Moscow Institute of Petrochemical and Gas Industry imeni Academician I. M. Gubkin, a cubic meter of slurry will require 1.3 tons of cement, and correspondingly a 1-meter length of a "pipe within pipe" structure would require 850 kg of cement (for 0.65 m^3 slurry which is 2.5-3 times more that the quantity of cement needed for variant II.

The weight of the "pipe within pipe" design with a sand-cement filling is equal to the weight of a gas pipeline ballasted with circular weights made from cast slag and concrete having a density of 3 tons/m^3, and much greater than the weight of a gas pipeline with a concrete coating having a density of 3 tons/m^3. The metal content of the "pipe within pipe" design is twice greater in relation to steel than for the other variants.

The most effective gas pipeline design is the one using a continuous concrete ballasting coating with a density of 3.0 tons/m^3 or cast slag of the same density. The least effective design is the "pipe within pipe" variant with sand-cement filling. It should also be noted that this design variant is associated with the greatest construction difficulties. Special difficulties arise in filling the space between the pipes (especially in curved sections) with the sand-cement slurry and in laying such a structure in its underwater trench.

The results of research on and analysis of the possible design concepts for underwater gas pipeline crossings consisting of 1,420 mm diameter piping permitted the following conclusions.

The optimum ballasting concept to be used in construction of 1,420 mm diameter underwater gas pipelines should be planned with a consideration for the characteristics of the water obstacle, the procedures to be used in laying the gas pipelines, the available transportation system and other local conditions.

The design in which the gas pipeline is ballasted by type UTK-1420-1 reinforced concrete circular weights should be broadly introduced into the construction of the multistrand gas pipeline system in the 11th Five-Year Plan.

Manufacture of cast slag and concrete weights with a density of 2.9-3.0 tons//m^3 must be organized, and assets must be allocated for construction of plants or of shops at existing enterprises to encase piping in concrete. After output capacities manufacturing concrete and cast slag circular weights are placed into operation, the use of cast iron weights on pipes with a diameter of 1,220 mm should be restricted. Such weights could be used at crossings erected in remote areas and wherever sharply bent sections are encountered.

Encasing underwater gas pipelines in concrete using a removable metallic form would be effective if plant-produced concrete could be delivered to the crossing under construction.

Before we can determine the suitability of introducing the "pipe within a pipe" design for 1,420 mm diameter underwater gas pipelines, we would need to compare the calculations for the different variants and the indicators of metal content, cement consumption, cost, labor outlays, construction time and the procedures used in construction of the crossing. Further improvement of the structure of construction subdivisions and introduction of new engineering concepts should insure integrated erection of crossings. It should also insure that an entire crossing, to include the floodplain section, could be delivered to the client all at once.

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COMPRESSOR STATION CONSTRUCTION IN TYUMEN OBLAST INTEGRATED, IMPROVED

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[Article by T. F. Khusnutdinov, Glavsibtruboprovodstroy, and V. F. Lysyuk, Kazymgazpromstroy Trust: "Construction of Compressor Stations on Gas Pipelines of the Tyumen North"]

[Text] Erection of compressor stations in the conditions of the Tyumen North is a complex engineering task, successful completion of which depends on many factors. Insufficient development of the transportation network, imperfections in the plans, lack of coordination among the activities of subcontractors and delays in supplying production equipment often make it necessary to extend the construction deadlines of the facilities. The Kazymgazpromstroy Trust has accumulated considerable experience in coordinated, highly effective work with associates. In particular the fifth and sixth generations of the Novokazymskaya compressor station servicing the Urengoy-Gryazovets and Urengoy-Petrovsk gas pipelines were placed into operation several months ahead of schedule, and the seventh generation of this station on the Urengoy-Novopskov route went into operation ahead of schedule as well. The new compressor station was a landmark among those built by the trust in 12 years of work in West Siberia--the 50th in number. The total power of the stations erected by the trust has now exceeded 3 million kw. In the last few years the trust has been regularly introducing five to six compressor stations per year.

In early 1970 the Komsomol Youth Construction and Installation Administration No 1, the country's first (now called the KMSMU-28), began erection of the first West Siberian compressor station at Punga equipped with type GT-6-750 gas pumping units.

The plans for the first compressor stations foresaw the use of monolithic foundations, application of "wet" processes in concrete-laying, masonry and plastering jobs, installation of brick walls and partitions, use of soft rolled roofing material and underground installation of engineering and utility lines. All materials and structures were delivered to the construction sites piecemeal. This meant high outlays. Frequent halts in the work of s small, narrowly specialized brigades and lack of coordination of their activities during the performance of associated operations caused the construction time to lengthen.

The standard construction time was halved in the 10th Five-Year Plan. This was promoted to a great extent by introduction of the modular method of erecting compressor stations in the Tyumen North. Now a single compressor station is erected in an average of 1 year, while some, for example Demyanskaya-II and Purpeyskaya-I, were built in as little as 6-8 months.

The trust collective is actively introducing progressive engineering concepts and structures, it is utilizing progressive work procedures, and it is constantly improving the organization of production and control.

The importance of limiting the use of monolithic reinforced concrete in the severe conditions of Siberian winters is well known. Metallic foundation mats were used for the first time to support shop frames in 1978 during erection of the Purpeyskaya compressor station. GTK-10 turbo-units were installed on piles made from 530 mm diameter pipes, making it possible to continue rigging and installation operations into the winter. The monolithic reinforced concrete slab serving as the foundation for the turbo-units was prepared later on, in summer, after the building of the compressor shop was erected. Concrete for the latter was hauled up using a bridge crane. Type 370 GTK-10 force pumps were installed in the same way, on steel caps. The trust decided not to lay power and heat supply lines in trenches, or the cables of monitoring and measuring apparatus in prefabricated reinforced concrete or brick channels. Metallic scaffolding was proposed in place of trenches.

Use of flat asbestos-cement sheets made it possible to reduce the labor outlays on finishing jobs associated with installing partitions. This design satisfies the strictest fire safety requirements.

These and some other engineering concepts--for example the use of metallic piles made from pipes of a diameter greater than that foreseen by the plan, use of steel foundations for STD-12500 machine units--allowed the collective to reduce the time of construction of each compressor station by 55-75 days.

Application of technical innovations went a long way to insure successful introduction of the integrated flow line construction method. This method made it possible to distribute the manpower and materials of specialized production teams equally and optimally throughout the entire construction time. Maximum integration of the activities of the general contractor and the subcontracting organizations provided the latter with ample work room at all times, and in the future it may be possible to perform all of the jobs of the preparatory and main construction periods in parallel. Anticipatory rigging of the gas pumping units, prior to erection of the shop frame, made it possible to immediately begin installation and connection of the pumping units, and major assembly of frames and enclosing structures at the construction site.

The integrated flow line method makes it possible to determine the optimum moments of starting and finishing low-volume, narrowly specialized jobs and minimizing the use of highly skilled labor.

The integrated flow line method made the work area available to specialized production teams of the subcontracting organizations three times faster, and it produced a national economic impact of about 1 million rubles owing to reduction of the time of construction of just a single compressor station equipped with GTK-10 turbo-units. In this case labor productivity climbed by an average of 10 percent, average annual wages per worker increased from 15,000-16,000 to 22,000 rubles, and construction time dropped 25 percent below standard.

Application of the integrated flow line method would have been impossible without efficient organization of administration and production documents. The work plans for each compressor station are drawn up by the Orgtekhtruboprovodstroy Trust, and using a computer, it also maintains operational control over construction progress.

Network schedules made it possible to efficiently distribute jobs among all of the specialized subcontracting organizations and to indicate the moments the operations were to start and end. No longer were there any jobs that were not assigned to a particular executor, the periods of idleness of associated subcontracting organizations decreased, and the number of conflicts in coordinating the work volumes dropped. The following principle was laid at the basis of organizing the main installation jobs: By the beginning of installation of ground production equipment and its connection, all underground engineering lines within the territory of the compressor station, to include the manifolds of the gas air coolers, the dust traps and the pressure regulators ["gitary"] must be laid and buried, and the manifold risers must extend above the surface of the ground.

The technological, technical and organizational measures implemented by the Kazymgazpromstroy Trust and the extensive use of the brigade contract both by subdivisions of the general contractor and by subcontracting organizations made it possible to reduce the time of construction of the pilot complex of the compressor station by 200-250 days.

While in former times the total labor invested into facilities belonging to the pilot complex of a single compressor station approached 150,000 man-days, today it is 55,000-60,000 man-days at construction sites where work had been started under previous methods, and 75,000-80,000 man-days at new construction sites. The average number of builders and installers employed throughout the entire time of construction is 250-280 at old construction sites and 310-350 at new ones.

The way the deadlines the general contracting and subcontracting organizations must observe in completing their construction and installation jobs are integrated right from the very beginning of construction can be graphically seen from the example of erection of the facilities belonging to the pilot complex of the Novo-Kazymskaya compressor station servicing the Urengoy-Novopskov gas pipeline, erection of which began in January 1982 (see Table).

Distribution of Work Volume Among General Contractor and Subcontracting Organizations During the Erection of the Pilot Complex of the Novo-Kazymskaya Compressor Station

	Estimated Cost of Construction and Installation Jobs, 1,000 rubles	Fulfillment of Construction and Installation Jobs, by Month, 1,000 rubles		
		January	February	March
Total cost	8020	24	189	365
To include that of the general contractor--Kazymgazpromstroy	5060	24	103	141
That of subcontracting organizations				
Total	2960	-	86	224
To include:				
SU-6 [Construction Administration No 6], Urengoygazmontazh Trust	1815	-	57	207
SU-8, Urengoygazmontazh Trust	202	-	-	10
SU-17, Surgutneftegazelektromontazh Trust	220	-	9	-
SU-7, Tyumengazmontazh Trust	188	-	-	-
SU-7, Gazmontazhavtomatika Trust	239	-	-	-
SU-21, Spetsneftegazstroy .	137	-	-	-
PMMK-5 [not further identified], "Sibkomplektmontazh"	129	-	-	-
Vostokburvod Trust	27	-	20	7
Nadim Communication Section, Surgutneftegazelektromontazh Trust	3	-	-	-

The accumulated experience is being used actively today in construction of the above-ground facilities of the Urengoy-Novopskov and Urengoy-Uzhgorod gas pipelines. In 1980 the trust is to place seven compressor stations into operation--five on the route to Novopskov and two on the export gas main. The work plans have been written up in detail. They foresee placement of these important national economic facilities into operation on schedule, and they define the work volume of each subcontractor. The metallic structures and larger parts required for the foundation level are being manufactured at the trust's central repair shops in the town of Beloyarskiy.

New domestically produced high-pressure GPA-Ts-16 gas pumping units will be installed for the first time at compressor stations servicing the Urengoy-Uzhgorod gas pipeline. These units do not require erection of a sheltering building, which will make it possible to almost halve the labor outlays associated with construction of the facilities of the pilot complex, and consequently to reduce the time of construction of the compressor stations even more.

The Shock Komsomol Detachment imeni XIX s"yezda VLKSM will make a substantial contribution to solving the important problems facing the trust collective. The young people did good work during construction of the Novo-Kazymskaya compressor station. Now the young men and women have been relocated to the site of the future Verkhne-Kazymskaya compressor station. A decision has been made to place it into operation ahead of schedule, simultaneously with introduction of the Urengoy-Uzhgorod export gas main. This will make it possible to immediately increase the gas pipeline's carrying capacity significantly.

Among the tasks of pipeline construction in the 11th Five-Year Plan, those of accelerating erection of compressor stations and increasing construction effectiveness are among the most important. Experience persuasively shows that construction of compressor stations could be accelerated only if construction is converted to an industrial basis.

To permit successful completion of this task in the conditions of the Tyumen North, where the main production bases are far away and roads are lacking, 2-year planning should be introduced, so that the necessary material-technical resources and equipment could be allocated and delivered to the construction sites a year in advance. More efficient forms of controlling the subcontracting organizations must be developed. Without a doubt the selection conferences that are held each week by the ministry are helping to solve many of the problems promptly. But the work volumes planned for the subcontractors are still not being tied in with the deadlines specified by the directives for placing the compressor stations into operation. Specialization in conditions where many of the organizations are hundreds and thousands of kilometers away from their main administrations and trusts must be sensible.

The collective of the Kazymgazpromstroy Trust knows that the enormous tasks associated with accelerating development of gas industry, posed by the 26th CPSU Congress, require a creative approach and a great deal of effort. Our goal is to build a compressor station within 4-5 months. This high goal is within the means of the trust's friendly well-coordinated collective.

11004
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PIPELINE CONSTRUCTION

UDC 621.643:621.791

'STYK' WELDING COMPLEX SUCCESSFULLY APPLIED TO GAS PIPELINE

Moscow STROITEL'STVO TRUBOPROVODOV in Russian No 1, Jan 83 pp 22-23

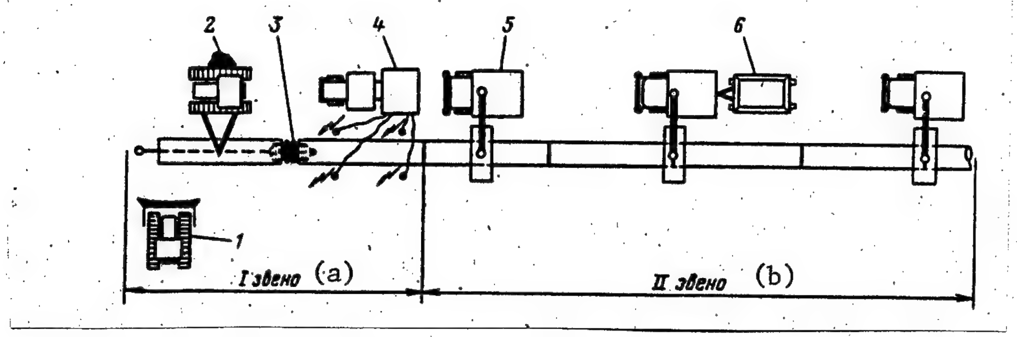
[Article by V. V. Kopyshevskiy, Ukrtruboprovodstroy Trust, Kiev: "Use of the 'Styk' Welding Complex"]

[Text] Hand arc welding of nonrotating joints on main pipelines is one of the most laborious operations. Achievement of an average daily rate of 1 km of 1,420 mm diameter pipes welded into a single strand requires the use of a brigade numbering a total of 44 persons. An automatic pipe arc welding complex introduced by the Ukrtruboprovodstroy Trust made it possible to significantly reduce the size of the welding brigade without decreasing labor productivity and work quality. This complex, called the "Styk-04," uses powder-filled welding wire, and it operates according to a forced seam forming principle. The complex consists of three self-propelled machine units and a mobile shop containing the auxiliary equipment.

The self-propelled welding unit is mounted on the chassis of a TT-4 skid tractor equipped with a 100 kw DEA-100B-M1 diesel electric power plant, three VDU-504 welding rectifiers, a self-contained station for cooling the forming sliders, and the welding head control blocks. The covered cabin of the welding unit contains a hinged rail track with two welding heads and a hydraulic system used to mount the rail track on the joint. The shop contains a wire winding machine, a furnace used to heat-treat the wire, a table-mounted drill and a work bench. The welding heads are controlled from a common console or from individual control consoles. The heads operate in two modes--working and traveling, and they are equipped with a system that adjusts, tunes and corrects wire feed and movement of the head itself and the forming slider.

The optimum arrangement of the equipment for nonrotating welding of pipe segments into a single strand is shown in the figure below.

A brigade consists of two squads. The first squad prepares the pipe segments, cleans them, preheats and hand-welds the root layer and "hot gap" with cellulose electrodes. The pipes must be assembled with a minimum gap of 1-1.5 mm so as to reduce the volume of the weld pool, and with a distance of not less than 600 mm between the lowest point on the pipe and the ground so as to permit passage of the welding heads. The second squad does the automatic welding using powder-filled wire and forced formation of the seam with filling and facing layers.



Arrangement of Mechanisms for the Work of a Welding Brigade: *1*--Bulldozer; *2*--pipe layer; *3*--inside centering guide; *4*--welding unit; *5*--"Styk-04" unit; *6*--mobile repair shop (a) Unit I; (b) Unit II.

The powder-filled wire is fed into the fusion zone bounded by the edges being welded, the surface of the "hot gap" and the forming slider. After the arc is activated a weld pool is created consisting of fused base and weld metal, protected from air by slag and gas formed by fusion of the core of the powder-filled wire.

As the fusion zone is filled, the welding head moves from bottom up. The wire is mounted at the extreme lower position tangent to the pipe surface, a minimum distance above the inside surface of the slider. During the welding process the wire moves into the welding groove, and its tilt angle increases, attaining 30-40 percent in the upper quadrant relative to the tangent to the pipe surface.

After the "hot gap" is welded by hand, the joint must be cleaned with a polisher, and the external reinforcer of the pipe's longitudinal seam must be removed for a distance of not less than 25 mm from the edge. All irregularities and beads are shaved off at this time. The welding groove is checked with a template.

The first gap is welded with welding heads equipped with toothed forming sliders. The time to weld the filling layer using two heads is 11-12 minutes.

After the filling layer is welded, the finish layer is welded by two other similar units contained in the complex and working two joints behind the first unit. The time it takes one unit to weld the finish layer is 18-20 minutes. Use of two units insures synchronous work of the entire brigade.

The complex is serviced by six operators, four of whom must be certified for hand welding, since if one of the units breaks down, the first filling layer following welding of the "hot gap" must be welded by hand using calcium fluoride electrodes. Moreover, after the finish layer is welded the welders polish and reweld defective areas detected by the operators during the welding process.

Using this procedure, the welding cycle for one joint, which includes travel time, stopping time and the time to service the welding heads, is 20 minutes, which is equivalent to three joints per hour.

Four welders and six operators can replace 18 to 20 top-class welders in the construction of the 1,420 mm diameter Urengoy-Pomary-Uzgorod gas pipeline. The need for draining slag can be eliminated by using PPAN-24A wire, which contains double the metallic powder and, simultaneously, a lesser quantity of slag- and gas-forming ingredients. Molybdenum powder added to the mixture raises the mechanical properties of the welded joints. The possibility for using a welding current of up to 400 amps reduces the time required to weld the finish layer to 14-15 minutes. It is now possible to use 3 mm diameter PPAN-24A powder-filled wire to weld the finish layer. Use of this brand of wire has been tested by our trust, and productivity has been demonstrated to be higher, despite the fact that the wire is more sensitive to pore formation and requires that the operators be more skillful. In the initial period of the complex's operation we ran into the problem of numerous defects, mostly points of unfused metal and pores, which arise especially frequently near the lowest and highest points of the pipes as well as in the "start" and "finish" sections.

We were able to subsequently reduce the frequency of defects by decreasing the assembly gap to 1-1.5 mm, by covering wire left over after the work day to protect it from precipitation and by using it up within the guarantee period. It is important to carefully clean and prepare the joint for automatic welding with powder-filled wire. All of the joints on the route were subjected to 100 percent control using an iridium-192 flaw detector. Defects for which each operator was responsible were analyzed in detail.

In the future, it would be suitable to use the "Styk" complex to weld individual pipes into a strand at the pipeline route. In this case the welding of the root layer and the "hot gap" should be separated in space so that two complexes could operate simultaneously. This will mean a productivity of six joints per hour, and it will produce a significant economic impact. It would also be necessary to practically solve the problem of using this complex to weld the root layer.

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WORKER COMPLAINT REGARDING OXYGEN SHORTAGES

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE in Russian No 1, Jan 83 p 69

[Letter to the editor from I. Mashkin, supervisor of the UTPK [Administration for Production and Technological Equipment Supply] group of "Vostoknefteprovodstroy," Ufa: "In the Role of Suppliant," and the editorial response]

[Text] Vostoknefteprovodstroy [Eastern Petroleum Pipeline Construction Trust] constructs gas and oil pipelines that run through the territory of several oblasts. We require a continuous supply of oxygen in order to operate smoothly and without delays. Oxygen is distributed in response to the user requests by the oblast planning commissions and the autonomous republic Gosplans. Therefore the pipeline constructors can not operate without the assistance of the local organizations. In most cases we find that these organizations understand our problems and support us. Unfortunately, however, this is not always the case.

For example, when we went to A. I. Demchuk, deputy director of the Tomsk Oblispolkom [Oblast Executive Committee] with a request for some oxygen he referred us directly to the managers of the plants having oxygen-producing facilities. We searched for a long time for such a plant, but with no results. At many of the enterprises we called on we were met with a questioning look: who are you, where are you from? It would appear that if the Oblispolkom personnel were more responsive to the construction workers' needs it would not be difficult to find the required supplies in Tomsk.

Another example, B. G. Permyakov, deputy director of the Udmurt ASSR Gosplan, suggested that we solve our "oxygen problem" at the Izhevsk Metallurgical Plant imeni 50th Anniversary of the USSR and at Izhtyazhbummash [Izhevsk Heavy and Papermaking Machinery Plant]. The Metallurgical Plant did not even bother to answer us, and at Izhtyazhbummash they turned us down, saying that they themselves use oxygen in large quantities for their processing needs.

So where can the pipeline builders get their oxygen? Well then, apparently a drowning man must save himself. We were forced to get our oxygen from the Bashkir ASSR. It was necessary to break the rules and ship the oxygen in tank cars and then truck it for hundreds of kilometers over poor roads or put in an order for a special helicopter flight. The construction schedules must be met! But such shipments involve considerable expense, which could be avoided.

The trunk pipeline routes do not run through populated regions, but rather stretch out over the remote taiga areas and through the uninhabited northern regions of the nation, through impassable swamps and mountain passes, and across many large and small rivers. Under the most difficult of conditions the pipeline builders are doing everything possible to meet the established schedules. They need assistance and support.

* * *

The editors showed Mashkin's letter to A. V. Rebane, a leading specialist of Giprokislorod [State Institute for the Planning of Oxygen Industry Establishments] of the Ministry of the USSR Chemical Industry. "Actually," he said, "the oxygen used in industry is one of the products whose production is not planned in advance. Each industry determines the volume of oxygen production as the need arises. However this practice has not worked out well well."

The raw material for the production of oxygen is atmospheric air, for which no one has to pay, and it would appear that there would be no need to establish a plan for its consumption. But it turns out that the separation of air into its constituent components (nitrogen, oxygen, argon and others) is a very expensive process, requiring significant energy expenditures. And it is often the case that someone needs only one of these components, and the other components, the production of which is an inherent part of the process, are discarded. Soyuzmetanol [All-Union Industrial Association for the Production of Methanol] monitors the allocation of the air separation facilities.

It is not difficult to see from Mashkin's letter that Vostoknefteprovodstroy is a major user of oxygen. But Vostoknefteprovodstroy does not have its own facility for producing oxygen. In all fairness, it should be said that their oxygen problem would not be so critical if the plan for organization of the operations involved in gas pipeline construction were more carefully thought out. Minneftegasstroy [Ministry of the Construction of Petroleum and Gas Industry Enterprises], of which Vostoknefteprovodstroy is a part, should delve more deeply into the routine requirements of the pipeline builders. The Ministry must be aware of the truck-mounted oxygen extraction units, intended specifically for the organizations whose operations are scattered over a large region. Such extraction units can be driven to the areas where oxygen is required for welding operations. Why doesn't Vostoknefteprovodstroy have such equipment?

Mashkin's complaints directed at the local organizations are quite valid. These organizations are obligated to offer all possible assistance to the oil and gas pipeline builders.

9576
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OCCUPATIONAL HEALTH AND SAFETY ISSUES IN PIPELINE CONSTRUCTION

Moscow GIGIYENA TRUDA I PROFESSIONAL'NYYE ZABOLEVANIYA in Russian No 12, 1982 pp 24-27

[Article by Yu. M. Bagdinov: "Technical Progress and Problems of Occupational Hygiene in Main Pipeline Construction," Institute for Main Pipeline Construction"]

[Text] In the growing pace and volume of main oil and gas pipeline construction, and attraction of a considerable contingent of workers to work in this field, problems of creating favorable working conditions are quite important.

An important place belongs to introduction of developments directed toward decreasing the amount of manual labor and transforming operations from field conditions to factory or semiportable, and also mechanization of basic technical operations.

The complex mechanization of operations in engineering preparation of construction routes facilitates a significant reduction in the volume of manual labor. Introduction of new technology for clearing trees with felling, felling-hauling and felling-piling machines will permit a significant reduction in the specific amount of manual labor and danger of injury since hazards associated with power saws were eliminated. Together with that, further development ofmeans to reduce the level of noise and vibration in the cabins of this type of machines is necessary.

On the pipeline construction routes, construction of temporary roads using wood local scrap wood, and unwoven materials, is widely used. (V.P. Mentyukov and coauthors). As calculations showed, introduction of such roads permit to reduce manual labor by 20 percent. In addition, the pace of pipe laying is considerably increased, and working conditions for construction workers and managerial staff are improved.

Welding and assembly operations appear to be the leading technological process in pipeline construction on which the lay pace depends. A great number of workers are engaged in this process. Providing favorable working conditions for them is an important task.

In connection with this, introduction of a series of new welding processes and equipment, fundamentally changing the nature of man's work during accomplishment of technical operations, deserves special attention. The creation and introduction of a mechanized platform for two-side automatic welding (O. M. Ivanov) provided complete mechanization of dangerous and laborious operations by having eliminated manual labor and handling pipes on racks, and substantially improved working conditions for welders. Welders' work sites are located in ventilated cabins; special devices with remote control, permit welding within pipes using a template, and eliminate the need for backing run operation for joints, since the wleder's work inside the pipe was eliminated.

The welder's work on a non-articulated joint, with a diameter of 1,420 mm, was significantly alleviated by introduction of an automated gaselectric welding system and equipment for welding large-diameter joints with powdered wires (A. G. Mazel' and coauthors). Development of a design for local exhaust ventilation and ergonomic fixtures for fitting an enclosure for the automatic gas-electric welding complex will allow to establish favorable working conditions and eliminate the effects of harmful substances on the welder (S. N. Zelenkin and coauthors).

Currently, work is underway on developing new processes and equipment that essentially eliminate man's direct participation in the welding process. Introduction of electrocontact welding equipment for large-diameter pipe joints (Yu. A. Anisimov and coauthors) allows a fundamental change in the welding process and gives the work of welders supervisory functions, in which observation and monitoring of the technological process from a remote control panel predominate. Health research data showed that welding technology, organization of work, and layout of the work place can practically eliminate effects of harmful substances, high levels of noise, and other unfavorable factors on operators.

Manual arc welding with electrodes continues to be used in welding pipe joints. When welding with electrodes, discharge of a number of toxic substances into the air in the work area is possible (Yu. M. Bagdinov and coauthors). With the aim of reducing such discharge during welding, VNIIST [All-Union Scientific Research Institute on Main Pipeline Construction] is conducting research directed toward health-safe modification of electrode composition formulas. One of the results of this research was the development of a new electrode. Chemical and health safety evaluation of the new electrode showed, that in qualitative and quantitative composition, the level of harmful substances discharged was 1.5-2.5 times lower than in welding with electrodes of different brands, but of the given type. Introduction of these electrodes also assures satisfactory inspection of root welds and eliminates the need to perform the laborious backing run welding operation for joints when welding pipe sections under route conditions.

Creation of special ergonomic fixtures, that promote convenient accomplishment of individual operations and physiologically sound placement of the welder during work is one of the important conditions in maintaining high productivity and preventing fatigue. These conditions will permit the provision of mobile equipment and a mobile cabin for simultaneous work of four

welders on one welded seam. Currently, at the VNIIST, work is being completed on creation of a mobile device and tests are continuing on a mobile cabin under route conditions.

Development and implementation of non-hazardous magnetographic and ultrasound monitoring techniques, as well as a greater volume of monitoring with the application of less powerful isotopes promoted reduction of work hours for monitoring quality control of welded joints and reduced the dangers during performance of these operations. Thus, for example, use of an automated ultrasound inspection laboratory assured a productivity increase of 5-6 times, in comparison with manual inspection and eliminated direct contact of the operator's hands with the U-3-scanner. The highly-practicable, mobile laboratories have the necessary sets of rooms, equipped with heating, ventilation, and water supply facilities that provide favorable working conditions for the operators.

Health safety research showed that for the workers the existing technology for cleaning and insulating the pipeline is influenced by aspects of heavy physical labor, dust, gases, noise, and unfavorable weather conditions. Introduction of polymer strip pipe insulating technology allowed to reform insulation without use of hot processes. Such operations are chiseling, smelting bitumen, and transport of hot mastic were abolished. Currently, nearly 85 percent of pipes are insulated by polymer strips.

Design and introduction of combined machines, that combine pipeline cleaning and insulating units, provide the potential to significantly lower the number of maintenance personnel and to improve working conditions. In the construction of the combined machines, progressive technical solutions were incorporated on the layout of basic mechanisms, which increases reliability of the machine on the pipeline, and eases maintenance and control. The combine is equipped with hoists for placing rolls of polymer tape on the insulating unit spools and a ventilation device for suctioning harmful substances from the cleaning unit and zones where soil and clay are deposited. Development of the remote control device for the cleaning and insulating machines permitted to remove the worker from the zone where dust, harmful substances, and noise can affect him. The device successfully passed the experimental use stage in a number of organizations of the industry (G. A. Nedoroslev and coauthors).

One of the main directions in improving work conditions at the pipeline insulation stage is industrialization of the technological process and transferring it from field to stationary conditions. Recently, an insulation platform was constructed, on which, according to technology developed at the VNIIST, the start up of a stationary pipe insulation device for pipes with a diameter of 1,220 and 1,420 mm, by means of electrostatic spraying of polyethelene, is being concluded. The technological process is completely automated and is carried out from a remote control panel (A. M. Zinevich and coauthors).

Among other important developments alleviating work conditions, the self-unloading pipe wagon, permits the elimination of a sling-man to unload pipe sections along the route. A prototype was tested and recommended for series production (V. F. Nikolenko and coauthors).

In order to maintain man's high productivity and reduce fatigue during work, we have developed a RTO Work and Rest Regiment (WRR), based on physiological research and cumulative work time. The WRR specifies work according to applicable graphs for cumulative work time and subsequent granting of uninterrupted rest. Depending on local conditions, the WRR has two variants of living, nutrition, and rest shifts: in a mobile complex directly on the route in the crew's work zone, and in an inhabited field town.

Experimental introduction of the WRR in a welding-construction crew working on a 1,220 mm diameter oil pipeline showed a positive result with respect to improved state of health, lowering of worker fatigue, and increased work productivity (Yu. M. Bagdinov). Based on the results of the research and experimental introduction, "Provisional state of the work and rest regiment for builders of the linear section of main pipelines" was developed and accepted by MINNEFTEGAZSTROJ [Ministry of Construction of Petroleum and Gas Industry Enterprises (A-U)].

Special conditions of linear construction, performing work in remote, often uninhabited areas, requires a comprehensive approach in solving problems of organizing work, living conditions, rest, and nourishment for workers. In order to provide favorable living conditions and good rest in pipe laying zones, consolidated field towns for 500-1,000 persons were constructed according to special designs.

To improve rest conditions for construction-installation crew workers during the work day, the "Crew mobile house-car" was developed with our participation. It has facilities for heating, rest and dining, for storing and heating food, lobby, and separate toilet. The house-car is equipped with an electric generator, independent water supply system, natural and mechanical ventilation, and a special lighting system.

In the set of organizational measures for maintaining optimal work conditions, control over air composition has an important place. However, in field construction conditions, performing of sanitary-chemical monitoring is linked with great difficulties. In connection with this, we are currently conducting research into a plan to possibly unify such monitoring.

Taking into account the stability of the welding mode and uniformity of technological operations in manual arc welding of pipe joints, the Laboratory of Occupational Hygiene and Physiology of Labor, VNIIST, conducted research in simulated and industrial conditions accordingly to determine the relationship between individual components contained in the welding aerosol compound. Based on a number of cellulose and basic types of electrodes, the presence of a definite relationship between the overall content of solid phase welding aerosol and individual escaping harmful substances (manganic oxide, silicon tetrafluoride, hydrogen fluoride, etc.) was shown. When monitoring of air content is achieved, this permits the determination only of the general content of solid phase welding aerosol and later the content of individual harmful substances in the air of the work zone can be evaluated via calculation or use of a nomogram.

The presented data show, that in this industry, much work is being conducted on the fundamental improvement of living and working conditions for workers. This is being achieved by implementation of accomplishments in science and technology, in order to optimize work and rest regiments, and by resolving problems of improved management over working conditions. However, there are a number of problems requiring solutions. Among research which will be conducted by VNIIST together with other departments, it is necessary to list work on the development of designs for ergonomic and hygienic-technical devices for new types of technological processes, machines and equipment, methodological recommendations on organization of medical examinations of pipeline workers; research into the function of thermoregulation and set-up of heating systems in various weather conditions, and on evaluation of workers' adaptation to conditions in the north and south.

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